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SOME BIOLOGICAL FACTORS IN AGING[1]

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From the time we start life as germ cells, we are in the process of aging. We do not become conscious of this often until "age begins to overtake us," but aging occurs with each hour, day and year, from the union of the reproductive cells which mark the beginning of life until the final end of life marked by death.

There is no good definition for the term "aging." Usually we think of the term as designating an increase in age in terms of years, or chronological age, yet we know that physiologically many persons are as young at an advanced chronological age as others at a much younger age. There is much controversy as to whether aging is an inevitable and essentially a physiological process, or whether it is a disease in itself.

The fact that it is inevitable was expressed by Warthin in his book entitled "*Old Age.*": "The senescent process is potent from the very beginning, involution is a biologic entity equally important with evolution—its processes are as physiologic as are those of growth. It is, therefore, inherent in the cell itself, an intrinsic inherited quality of the germ plasm, and no slur or stigma of pathology should be cast upon this process. Senescence is due primarily to the gradual weakening energy charge set in action by the moment of fertilization."

The fact that aging is a disease (as related to the brain) in itself was expressed by Tilney: "No evidence thus far adduced is sufficient to convince us that there is such a thing as a strictly old brain. The brain in aged people may present certain morbid changes, but these are in their turn incident to many pathological assaults upon the tissues sustained during life which, in some individuals more, in others less, are in all alike in consequence of infections, intoxications, or other morbid influences. All of this is a strong argument in favor of the theory which holds old age in the brain, as in other organs, to be the result of life's successive and cumulative intoxications. —According to this view, old age has a pathological background. It arises from definite conditions which may be combated or corrected."

It is not my purpose to attempt a discussion of these points of view. That is a job for the specialist, the pathologist. My interest in the problem of aging, aside from the fact that I am actively engaged in the process and thus like most of you have a natural interest, lies in the fact that I have done some research on certain phases of the problem as it relates to a very limited area of the body. That work gave me an interest to choose the topic for this talk. As I have surveyed the field of literature available, I am impressed with the fact that there are also a lot of other persons who are growing older. There is a tremendous bibliography

[1]Presidential address delivered at the Annual Meeting of The Ohio Academy of Science at Ohio Wesleyan University, Delaware, Ohio, April 22, 1955.

available on "*Aging*," ranging from biological studies, both anatomical and physiological, through psychological and into sociological studies.

In the introduction to the book entitled "*Problems of Ageing*," Dr. John Dewey wrote a very interesting statement on aging. I quote portions of this: "The underlying problem (in aging) both scientifically and philosophically, it seems to me, is that of the relation of aging and maturing. We are at present more or less in the unpleasant and illogical condition of extolling maturity and deprecating age. It seems obvious without argument that there is some connection between the two; that we cannot separate the processes of maturing from those of aging, even though the two processes are not identical. The split that now exists between the two, in terms of both individual activity and happiness and of social usefulness, would appear to be socially or culturally produced, rather than to be biologically intrinsic. That there should be a gradual wearing down of energies, physical and mental, in the old age period, it is reasonable to expect upon biological grounds. That maturing changes, at some particular age, into incapacity for continued growth in every direction is a very different proposition. We may not be able to affirm with the poet—

Grow old with me
The best is yet to come

but there is something abnormal in the situation if we are obliged to admit that after a certain period nothing better in any direction, individual and social, can occur because of the process of growing old."

Early in my graduate training I had a course in Embryology with the late Dr. B. F. Kingsbury at Cornell University during which he made a statement that at the time surprised me, as well as interested me very much. He, one day in lecture, indicated that "We grow oldest fastest while we are youngest." As we analyze the rapid rate of early development, beginning with an unfertilized ovum and a viable spermatozoon, and realize that in about four months' time the entire pattern of the human body has taken form, we then realize that the greatest progress in growth of the body, not quantitative growth but qualitative growth, does occur in a very short span. True, there are important developmental changes which occur during the remainder of the prenatal period, yet the basic fundamental plan isn't greatly altered.

In many, in fact, in most of the body systems, there are few important basic changes except in quantitative growth after birth. In the nervous system, for instance, it is well established that we are born with as many nerve cells as we will ever possess, and this number is far in excess of the number needed or used. Any cells which may be destroyed are never replaced. The fact that we have this marked surplus in number of cells gives us great comfort, yet degeneration in some of the vital areas and usually quite limited areas, may leave us at any age in a very helpless condition.

All living organisms pass through a sequence of changes which include development, growth, maturation, and senescence. These are commonly used biological terms and cannot be regarded as highly technical when we think of the process of life and of living. Since all these factors are involved in the life span, the question of aging presents a very broad biological problem. The rate and expression of aging vary greatly in different organisms, so that no general theory of aging is available and the problem of senescence in any group of animals must be regarded as a distinct problem within the larger biological question.

Since growth and the aging process are very rapid in early development, I have chosen to discuss some of the biological factors which operate during prenatal growth. Development is a structural or anatomical and a physiological process. The anatomical process deals with form, structure, and relations. The physio-

logical process is concerned with the way parts interact in the developing or evolving embryo.

I should like here to draw very heavily from the embryologists who are concerned with the origin and development of the individual as an organism. It is a well known biological maxim that all life comes from preexisting life and that the process of growth, that is a developmental increase in mass, is an important factor in development. As pointed out by Just, Lillie, and many other embryologists who have been concerned with the very early developmental processes, growth is accomplished in several ways: 1) synthesis of new living material (protoplasm) from foodstuffs, the foodstuff providing the nutritive factor; 2) growth by water uptake, this being particularly important in the very early weeks of development when fluid constitutes nearly 98 per cent of the human embryo; and 3) growth by manufacture and deposit of non-living substances, the material being of the nature primarily of intercellular substances, as the ground substance in skeletal tissues.

Growth is not of the same rate and of the same relative importance in different parts of the same organism, so that it is evident that uniform growth cannot produce changes which result in progressive alteration of form and proportions. The various rates constitute what may be termed *differential growth* and this is accomplished in spite of the fact that various parts of the body appear and begin to grow at different times.

Growth is made possible by and is under control of certain factors, a few of which will be discussed briefly:

1) The constitutional factor. Every zoological species has its characteristic rates and limits of growth. Under identical conditions of development the speed of growth is approximately the same in all individuals of a species, and there is little difference in the final size attained. This is due to inherited qualities that predispose toward a definite basic rate of cell division and growth.

2) Temperature. Growth rates vary with temperature, there being an optimum temperature in which growth is most favorable. In the mammal in which we have internal development within the female reproductive tract, there is a very fixed temperature and the rate of growth is constant, and the end of development preceding birth and the time when birth can be anticipated is so constant that a formula has been developed, which with rather minor variations, can be counted on as being a reliable guide as to when birth can be anticipated. On the other hand, in a form in which development occurs outside the fixed temperature conditions afforded by internal development, variations in temperature exert a marked influence on the rate of development. In the incubation of the chick, for instance, the optimum temperature is near 103° F. If this temperature is lowered, yet not low enough to arrest development completely but only to retard the rate, a longer time is required for hatching.

3) Nutritional factors. The requirements for growth through new tissue building are more demanding than those that suffice for the maintenance and repair of protoplasm which is already present. Food must not only be suitable but also adequate in amount if growth is to occur. There is a minimum below which growth fails. Above this level growth accelerates, but it cannot exceed an optimum rate, characteristic of the organism, even if excess food is available.

4) Growth-promoting factors. There are certain substances which are non-nutritive which further the process resulting in the production of new basic living materials:

a) The embryonic factor. The exact nature of this factor is not known but it has been demonstrated that when tissue is grown outside the body in a nutrient medium, that growth is stimulated by the addition of juices from the body to the medium. It is presumed that this same factor has an influence within the body.

b) Hormones. Some of the endocrine secretions are promoters and regulators of growth. The secretion of the thyroid and of a portion of the pituitary are particularly significant in this respect.

c) Vitamins. These are of plant origin in the animal diet. The absence of vitamin A in the young animal results in a failure to gain weight. An absence of vitamin B_2 results in growth failure.

Cell growth as an embryonic factor and as an adult factor is quite different. In embryonic growth there is not the highly developed level of specialization as is found in post-natal growth. There is a fundamental antagonism between cell differentiation and cell proliferation and the factors which promote differentiation make proliferation increasingly difficult. The cell types resulting from the process of differentiation are distinct and specific entities, and not transitional forms; this means, for instance, that a cell is never a cross between an epithelial cell and a muscle cell. Once a cell is committed to any type of differentiation it cannot engage in another type, nor can it abandon its original line of specialization in favor of another course. Furthermore, a course of differentiation followed by a cell always follows the distinctive way that is characteristic of the species to which the embryo of which the cell is a part belongs.

Aging cannot be ascribed to any single structural or functional change or failure, and there are variations in functional activity of tissues and organ systems among individuals of the same chronological age. One of the most commonly accepted reasons for retarded senescence is adequate nutrition which not only reflects itself in the growth process but in the maintenance of youthful characteristics. As knowledge of nurture, and especially of nutrition, has advanced and is advancing, some of the better nurtured children may have a rate of senescence much more favorable and quite different from the present picture of aging.

Time is of the greatest significance in studies of growth and of aging. It may be assumed that members of *a species* of the same chronological age may constitute a homogeneous group in the aging process, but studies on children and different animals have indicated that individuals grow, develop and mature at different rates and thus differ decidely at the same chronological age. Dr. Alexis Carrell and Dr. Lecomte du Nouy have tried to differentiate time rate within individual organisms in their concepts of "physiological time" and of "biological time." It has been asserted that "time produces no effects—events occur in it but not because of it," which implies that time is a frame of reference for measurement of change but may be relative to the individual organism.

It is interesting to compare and contrast some of the factors which operate in aging in plants and in animals, and in lower animals and higher animals, and from such comparisons and contrasts we can observe, or perhaps draw some conclusions relative to the aging process.

Not being a botanist, I hesitate to attempt to make mention of the problem of aging in plants, but I feel on safe ground if I may be allowed to summarize some of the discussion given in a most interesting article by Dr. William Crocker, the late managing director of the Boyce Thompson Institute for Plant Research, Yonkers, New York. Dr. Crocker indicates that it is impossible to discuss aging in all plants under one concept because there is such a range of plants as to life course and life duration. The problem of aging in plants is rendered complex by the fact that the life span of a given plant in nature may be modified greatly by growing it under conditions that vary considerably, or in some cases even slightly from the conditions it meets in nature.

In the main, plants form an open system, that is, they continually develop new growing points, whereas animals more often form a closed system. This means that plants in general do not have a definite or even an approximate life span in contrast with animals. Certain plants are theoretically immortal, that is, they die only because of unfavorable external conditions. This is true of plants in which

all the cells remain embryonic instead of differentiating into reproductive and somatic cells. Even some plants that in nature differentiate into somatic and reproductive cells can be grown continuously vegetatively by the proper cultural conditions. Hartmann grew Eudorina elegans, a colonial alga, for 1300 generations over a period of five years, without any differentiation of cells beyond embryonic cells.

As we pass from plants to a consideration of animals, let us begin with the single celled animals or the Protozoa. In view of the nature of the life cycle of the Protozoa, the age problem has a two-fold bearing:

1) The individual is a free cell, which performs all the fundamental operations of life; and 2) more important is the following: The single cellular individual as a rule does not as such die; instead it grows and divides into two individuals. This continues so that chains of free individuals are produced, stretching for many cell generations. These are interrupted at long intervals by the union of two individuals in sexual reproduction. After this, the chain of free individuals continues. The question then is: Does the chain of successive living cells, through the process of living, gradually become senescent in its later links, so that it declines and finally dies, unless something intervenes to save it?

During fission or simple reproduction in the Protozoa, many of the characteristics of the adult do not at first appear in the offspring, but such characteristics, both internal and external, do gradually reappear as the individual grows older, thus the young offspring are at first "young" as compared with the parent. But the question remains whether the rejuvenescence so produced fully restores the primitive condition. The chain of living cells extends for hundreds or thousands of generations. Are the later members of the chain as young physiologically as the earlier members? The following are a few observations relating to the answer to this question in the Protozoa, and to similar questions in higher animals:

1) When chains of living cells are kept under observation in the laboratory, so that their fate can be determined, as has been done with many species of Protozoa, it is found as a rule that after some hundreds of generations they do decline. Fission and other life processes become slower, resistance decreases, functions are imperfectly performed. Various structural changes occur. All these factors give a picture of senescence which finally extends to death.

2) In Protozoa, it has been demonstrated that in full active living there are always kept in store fresh unexhausted parts which do not participate in the major activities of life and which can be brought into later use. In the higher organisms these are complete cells. *The presence of such fresh unexhausted parts is the secret of continued life.*

3) In the invertebrates, we find extensive if not universal use of the device of keeping certain parts of the organism out of the main current of the life activities, forming a reserve, which is substituted at intervals for worn parts. In the multicellular organism these reserve cells have the capability of developing and taking on all the activities of the organism. These are known to us as germ cells, but many organisms have other reserve cells known as embryonic or regenerative cells, which remain dormant but can be roused to active life by appropriate conditions. In the metazoa, the cells which take an active part in the life of the individual are subject as a rule to decline or senescence. In addition to the senescence of the individual cell, or in consequence of it, there is, as in the vertebrates, a general senescence of the entire body, culminating in death.

4) By contrast with the situation in plants, in animals the embryonic condition is not maintained in the metazoa or multicellular animals. In these we recognize somatic and reproductive cells almost from the beginning of development and the somatic cells are of various types and are organized into more complex units, the tissues. Tissues in turn are organized into still more complex units known as organs; as the heart, stomach, etc., such organs often presenting a combination of

all the fundamental types of tissues, so when we recognize senescence in an individual, it may be due to a degenerative process in an individual tissue, but more often many tissues are involved, and apparent aging in one organ or system may actually be a secondary effect resulting from aging in another organ or system.

It is of interest to review here some brief observations relative to the process of aging in man. Only a few of the body systems will be mentioned. Certain factors in aging will be apparent from these observations. Aside from the predominance of the congenital conditions as a cause of death in early infancy, deaths at ages under 40 are largely of infectious or accidental origin. Beginning with age 40, the cardiovascular-renal diseases (*i.e.*, chronic diseases of heart, chronic nephritis, cerebral hemorrhage and paralysis without specified cause, diseases of the arteries, and angina pectoris) assume rapidly increasing importance. More than one-fourth of the deaths in age group 40–49 arise from degenerative conditions in this category. The proportion of deaths from such diseases thereafter mounts until in age group 80–89 they account for two-thirds of all deaths. Cancer first becomes an important factor at age 40. Among females between 40–59, cancer causes about one-fifth of all deaths; among males between 50–69, about one-eighth of all deaths result from this cause. Accidents, important in mortality during youth and early maturity, are of importance again in old age.

Death in the aged is apparently only rarely due to a wearing out of the digestive system. Most elderly persons die with a digestive system when not directly affected by cancer, by a toxic or by an infectious process, that is capable of functioning beyond the ordinary life span. The consequences of aging *per se*, are not serious. It is striking that during life, symptoms referable to the gastrointestinal tract occur more frequently than to any other system in the body. This is because the alimentary tract is so readily influenced reflexly by mental states and by disease elsewhere in the body, and because many of the symptoms of disturbance of the tract are functional in nature and tend to respond readily to diet and rest. This is why Josh Billings wrote: "I have finally kum to the konklusion that a good reliable set of bowels is more to a man than enny quantity of brains."

In lower vertebrates and in the embryonic mammal, degenerative changes are observed with aging of the kidney. Senescence has been looked upon as involution due to a decrease in the vital energy of the cells. If such a primary senescent involution occurs in the kidney of man, it is obscured and its effects over-shadowed by secondary tissue changes that develop as a result of the normal aging of the renal arteries. Aging of the human kidney becomes, therefore, a special case of aging of the vascular system.

Age changes in tissues of the body, excluding blood and body fluids, are chiefly those of dehydration with reduction of intracellular fluid and an increase of intercellular fluid and in addition a certain faltering in the orderliness of tissue pattern. These changes also indicate the course of transformation from the orderly and reversible phenomena of health into the disorderly and irreversible which are the stigmata of disease.

Tendons and ligaments, synovial membrane and connective tissue, show no clearly defined age changes, but do present, as age advances, the cumulative effects of imperfect repair and constitutional defect. Smooth muscle is another tissue for which no age changes have been recorded. Chemical changes in skeletal muscle with age indicate a decrease of intracellular fluid and an increase of intercellular fluid.

Dr. Hefner, as retiring president of the Academy last year, made a significant point in his presidential address to the effect that no selective factor is so fatal to the maintenance of the proportion of persons with higher intellectual qualities as not being born. But after a person is born, if he is to make the greatest contribu-

tion to society it is important that he have a relatively long life span in which to make this contribution.

Our present knowledge of aging and death indicates the importance of the genetic or hereditary factor. There can be no doubt that in all animals from the single celled Protozoa, through the invertebrates and vertebrates to man, the length of life is largely determined by inheritance. In fruit flies a single gene may make a great difference in length of life. In humans there are long and short lived families and the genetic constitution is an important factor in aging. Another important factor that has been mentioned in early development and in the adult is the nutritive factor.

If we could be fortunate enough to be born and to be able to select our parents on the basis of the genetic factor for longevity and the financial factor to provide good nutrition, we could have a reasonable chance to reach a ripe old age, if we could avoid the accident factor. The fact that we are here indicates we got by the first hurdle of being born—how long we will be here will be largely determined by the other three factors.

To those of us who are old enough or are aging rapidly enough to be conscious of the process taking place—and often with great speed as we feel at times, we may be encouraged for the younger generation by the following from the March-April, 1954, issue of the Bulletin for Medical Research:

"The chances of anyone's living to the age of 65 continues to get better and life expectancy past that point is on the increase. More than three-fourths of all women born last year will live to be at least 65, and nearly two-thirds of all men born last year have the same chance. Furthermore, half of the women who reach 65 will go on to age 80, and quite a few of them will celebrate their 88th birthdays. Half of the men reaching 65 will survive to 77."

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How to know the Fresh-water Algae. *G. W. Prescott.* Wm. C. Brown Company, Dubuque, Iowa. 1954. iii+199 pp. Spiral, $2.00; Cloth, $2.75.

The author, who is an outstanding specialist in his field, has succeeded in contributing a manual for the more common algae which should appeal to the general student and to the specialist alike. A welcome innovation is the inclusion of illustrations of one or more species of each genus at the point where that genus appears in the Key. Basically however it is a Key to the Genera.

The introductory remarks concerning the nature of Algae, their collection, and the selected references as well as an illustrated glossary and the latest taxonomic treatment of the group combine to make this book a desirable tool for those interested in aquatic biology.

C. E. TAFT

THE TAXONOMICS OF THE GENUS *PROTOGYNELLA* JONES, 1943 (CESTODA: HYMENOLEPIDIDAE), WITH A DESCRIPTION OF *PROTOGYNELLA PAUCIOVA* N. SP. PROVIS[1].

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Jones (1943) established the genus *Protogynella* to receive a species of small tapeworm which he recovered from the short-tailed shrew, *Blarina brevicauda* (Say), collected in Virginia. He described this tapeworm, *Protogynella blarinae*, as having an unarmed rostellum. In addition the tapeworm was characterized as having a single testis which developed in each proglottid after the ovary had reached maturity, thus giving rise to a protogynous condition.

Rausch and Kuns (1950) recovered a small tapeworm from *Blarina brevicauda* in southern Wisconsin which they identified as *Protogynella blarinae*. However, they reported that the rostellum was armed with 45 hooks about 5 μ long and therefore suggested a modification of the generic concept.

Locker and Rausch (1952) reported *P. blarinae* from shrews collected in Oregon. They noted that the rostellar hooks were more numerous in the Oregon specimens, and suggested that *P. blarinae* was variable in this respect.

During 1950 the intestinal tracts of 30 short-tailed shrews were examined by the writer. Five of these shrews were infected heavily with minute tapeworms of the genus *Protogynella*. The material from three shrews was decomposed too badly to be of value for study. However, 260 specimens from a shrew collected in Hocking Co. and 29 specimens from a shrew collected in Franklin Co., Ohio, were recovered in good condition and form the basis for the present study.

OBSERVATIONS AND DISCUSSION

The specimens of *Protogynella* from Hocking Co. were compared with the type specimen of *P. blarinae* (Slide No. 165133, Helminthological Collection of the U. S. National Museum) and were found to be identical. Close examination of the type specimen revealed six proglottids, directly at the base of the scolex, containing a single testis each. These testes were poorly differentiated by the stain, and it seems probable that they had been overlooked in the original study. The seminal vesicles in about the seventh proglottid, which had been described as devoid of sperm and in an immature state, actually contained sperm. This condition, together with the fact that the testis develops before the ovary, rules out protogyny for this species.

The rostellum of the type specimen is partially protruded. Only a few hooks are visible; the rest have apparently been lost. Dr. A. W. Jones re-examined the type and paratypes of *P. blarinae* from Virginia as well as about 75 specimens from Ohio, at the author's suggestion, using the phase microscope. He concluded (personal communication) that the number of hooks may be variable, but is probably close to 250. The hooks occur in several irregular rows or tiers, thus forming a band around the face of the rostellum.

To justify the erection of the genus, Jones (1943) had maintained that the unique combination of characters of *P. blarinae* would not allow its inclusion in any established genus of the family Hymenolepididae. The observations of

[1]In part from a thesis presented in partial fulfillment of the requirements for the degree Master of Arts in the Department of Zoology and Entomology, the Ohio State University.

Rausch and Kuns (1950) and Locker and Rausch (1952) together with the present study reveal that two of the morphological bases used in establishing the genus, i.e., protogyny and an unarmed rostellum, were fallacious. Nevertheless, the characters of *P. blarinae* remain unique within the family. The single testis would immediately place this tapeworm in the genus *Haploparaxis* Clerc, 1903, since this is the only genus in the family which possesses this important characteristic. Clerc, however, in defining the genus states: "Rostellum armé d'une couronne simple de crochets." In *P. blarinae*, the hooks are arranged in several closely set rows. Moreover, the extremely large number of hooks is important since in *Haploparaxis* the hooks number only ten with the exception of *H. dujardinii* (Krabbe, 1869) which possesses forty-six. In addition, all known species of *Haploparaxis* are confined to avian hosts. Thus the single testis of *Protogynella*, together with the morphology of the rostellum, the extremely small size of the worm, and the fact that its host is a mammal, justify the retension of the genus.

Protogynella Jones, 1943 *genus emended*

Diagnosis: Size small, usually less than 1 mm. in length; strobila not serrate; 15 to 32 proglottids in specimens observed. Scolex roughly spherical with four muscular, unarmed suckers. Rostellum muscular, protrusible; armed with a large number of minute, Y-shaped hooks occurring in a single row or in several overlapping rows or tiers. Common genital pores unilateral. Female organs median and ventral to male organs; male and female ducts pass dorsally to excretory canals. Vitellarium ventral, compact, aporal to ovary and seminal receptacle. Testis dorsal, single, evident only in very young proglottids. Uterine pocket fills entire gravid proglottid except region of male system. Single layer of longitudinal muscles, central to band of circular muscles. Condition of protogyny not present.

The following redescription of *P. blarinae* is based on the type specimen and the material from Hocking Co.

Protogynella blarinae Jones, 1943
(Figures 1, 2, 5 to 9, and 12)

Diagnosis: Total length 440 to 750 μ; greatest width 101 to 162 μ, attained in gravid proglottids. Scolex prominent, 115 to 138 μ long and 149 to 190 μ in diameter; four muscular, unarmed, cup-shaped suckers 46 to 68 μ in diameter. A muscular, armed, protrusible rostellum, 54 to 63 μ in diameter, surrounded by a sac 102 to 123 μ long and 61 to 89 μ in diameter. Rostellar hooks about 250 in number and about 4 μ long. Hooks Y-shaped, arranged in 2 or 3 overlapping rows or tiers. Strobila slightly flattened dorso-ventrally; edges not serrate; consisting of 17 to 32 proglottids which are wider than long. A single layer of non-fasciculated longitudinal muscle fibers. Genital pores unilateral, dextral. Two pairs of undulating longitudinal excretory canals passing ventral to genital ducts; transverse connectives lacking; dorsal canal 0.7 μ in diameter; ventral canal 2.0 μ in diameter. Testis single, compact, and ovoid with long axis transverse; located dorsal and aporal to sagittal plane; maximum size, reached in 6th or 7th proglottid, 17.2 by 6.9 μ. Cirrus sac 34 to 53 μ long and 7 to 10 μ in diameter; located slightly dorsal to medial-frontal plane and extending from the genital atrium to midline of proglottid; internal seminal vesicle 18 μ long. Cirrus 13.5 by 2.5 μ when retracted; without spines. External seminal vesicle elongate, pyriform, recurved porad dorsal to cirrus sac. Vagina ventral to cirrus sac, 1.4 μ in diameter and lined with cuticle for 13.8 to 16.5 μ of its length; vaginal cuticle provided with minute papillae. Seminal receptacle transversely elongate; ventral to cirrus sac and dorsal to ovary. Ovary ovoid with long axis transverse; located ventral and median in proglottid;

maximum size, reached in 13th or 14th proglottid, 32.4 by 13.0 μ. Vitellarium roughly spherical; located aporal to ovary; largest diameter, 10 μ. Uterus transverse, sac-like, occupying entire gravid proglottid except region of cirrus sac. Two to six terminal uteri each with 6 to 8 fully embryonated eggs enclosed in membranes. Eggs ovoid, 46.2 to 63.2 (av. 57.2) μ by 37.0 to 46.2 (av. 41.5) μ in size. Three egg membranes present; outer membrane 0.7 μ thick, pitted on surface; middle membrane thin, irregular, granular; inner membrane 1.4 μ thick, hyaline, typically with two filaments at each pole. Larval hooks 11.7 to 12.4 μ long.

Host: Blarina b. brevicauda (Say)
Locality: Charlottesville, Virginia (type) and Hocking Co., Ohio.
Habitat: Small intestine.
Life cycle: Unknown.

Development of Genitalia

A study of serial transverse sections and toto-mounts of *Protogynella blarinae* revealed a rather unique development of the sexual organs. Functional testis and ovary do not occur in the same proglottid. The testis develops, matures, and completely disappears before the ovary reaches maturity.

The testis is evident in the proglottid immediately at the base of the scolex, and it reaches its maximum size in the sixth or seventh proglottid (fig. 5). At this time the cirrus sac and external seminal vesicle are still in the formative stage. The genital atrium and vagina are evident as cavities in the mesenchyme. The lumen of the seminal receptacle arises by the differentiation of a group of cells at the extreme poral side of a ventral mass of formative tissue.

After the testis has reached its maximum size, spermiogenesis occurs, and the testis disappears completely in the ninth to eleventh proglottid. The cirrus sac, seminal vesicles, vagina, and seminal receptacle become functional in the first or second proglottid in which spermiogenesis is occurring at which time the seminal vesicles and seminal receptacle contain sperm (fig. 6).

In the sixth proglottid, the anlage of the ovary appears in the most ventral portion of the mass of formative tissue. The ovary becomes distinct in about the eighth proglottid. The anlage of the vitellarium also appears in the sixth proglottid. It becomes more fully differentiated in succeeding proglottids.

The ovary and vitellarium reach their full size in the thirteenth or fourteenth proglottid. In the following proglottid, the ovary has disappeared, and a uterus containing zygotes or early cleavage stages is present (fig. 9). The uterus develops from the dorso-median mass of formative tissue, its lumen appearing in this group

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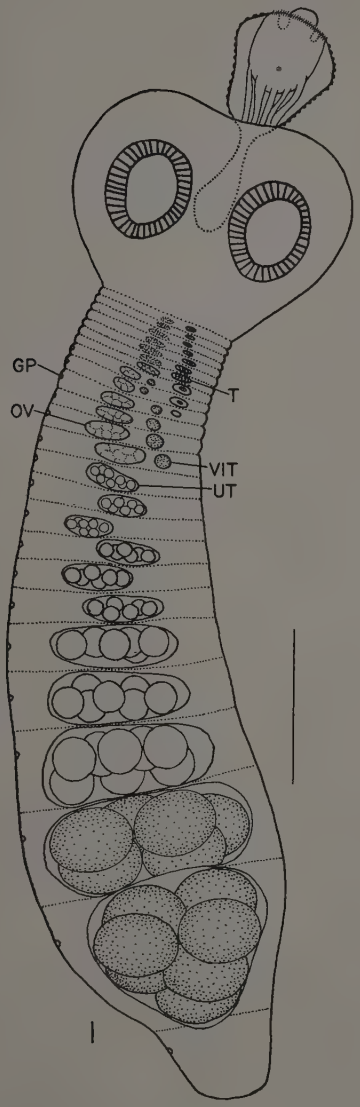
EXPLANATION OF FIGURES IN PLATE I

1. Ventral view of *Protogynella blarinae* Jones, 1943. Cirrus sacs and accessory organs have been omitted for clarity. Scale has value of 100 microns.
2. Rostellar hook of *P. blarinae*. Scale has value of 2 microns.
3. Ventral view of *P. pauciova* n. sp. provis. Cirrus sacs and accessory organs have been omitted for clarity. Scale has value of 100 microns.
4. Rostellar hook of *P. pauciova*. Scale has value of 2 microns.

ABBREVIATIONS USED IN PLATES

AU anlage of uterus
GP genital pore
OV ovary
T testis
UT uterus
VIT vitellarium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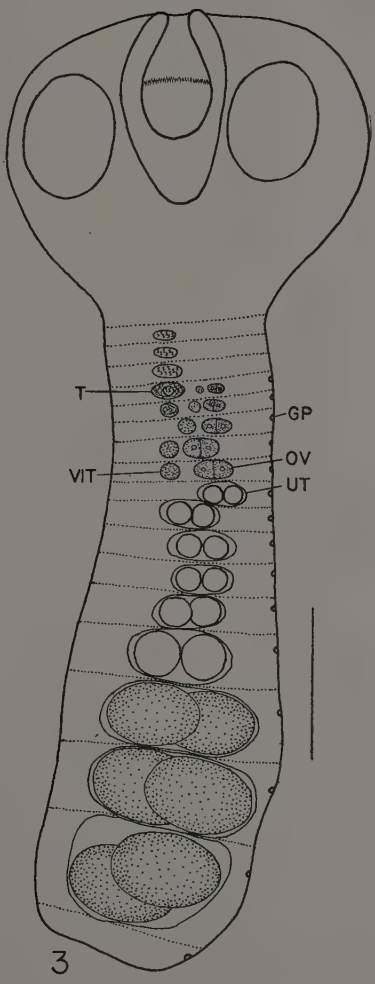
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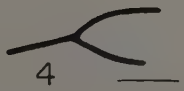
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of cells in about the thirteenth proglottid (fig. 8). The uterus is closely applied to the dorsal ovarian wall. The seminal receptacle, which has elongated aporad, is in close proximity to the dorsal surface of the uterus.

Exactly how the eggs enter the uterus and are fertilized was not apparent in this study. Apparently, however, the ovarian wall ruptures, and ova are liberated into the uterus. Fertilization would appear to be intra-uterine. Whether a duct leads from the seminal receptacle to the uterus could not be determined. Such a sperm duct might not be necessary. In the Acoleidae, in which the vagina is absent, fertilization is accomplished by the injection of sperm from the cirrus directly into the mesenchyme. This would suggest that sperm might leave the seminal receptacle and migrate through the mesenchyme into the uterus where the ova are fertilized. Yolk material also enters the uterus at this time, but its method of entrance is unknown.

Cleavage and formation of hexacanth embryos occur in succeeding gravid proglottids. The eggs, which are fully embryonated in two to six terminal uteri, are surrounded by three membranes. Such eggs are liberated by the rupture of the proglottid. One or more terminal proglottids, devoid of eggs but retaining cirrus sacs, are usually present. Atrophy and sloughing of these proglottids presumably occurs.

Variation within the Genus

Toto-mounts and serial sections of *Protogynella* from Franklin Co., Ohio, have been studied, and several striking differences in comparison to the typical *P. blarinae* were noted.

In *P. blarinae*, the genital pores are dextral, the cirrus is aspinose, and there are from six to eight eggs in each gravid proglottid, each egg being provided with two filaments at each pole. In the 29 specimens of *Protogynella* from Franklin Co., the genital pores are sinistral, the cirrus is spinose, and there are only two eggs in each gravid proglottid. These eggs are without polar filaments.

Dr. Robert Rausch has kindly sent the author several slides of *Protogynella* from *Sorex v. vagrans* Baird collected in Oregon and from *Sorex c. cinereus* Kerr collected in Wisconsin. As is so often the case when working with helminths of shrews, decomposition had set in before the cestodes were removed from the host, and the material is consequently in poor condition. The following superficial observations were made, however, using the phase microscope.

Locker and Rausch (1952) reported that the number of rostellar hooks is near one hundred in *Protogynella* from Oregon shrews. This observation has been substantiated by the writer (estimates of 94, 98, 112, 125). Unlike *P. blarinae*, the hooks occur in a single row. The genital pores in these specimens are dextral, the cirrus is spinose, and the number of eggs varies from six to eight per gravid proglottid. The presence of polar filaments could not be determined because of the shrunken condition of the egg membranes.

In the material from *Sorex cinereus* collected in Wisconsin, the rostellar hooks number about eighty (estimates of 75, 78, 81, and 87) and occur in a single row. In these specimens the genital pores are sinistral, the cirrus is finely spined, and

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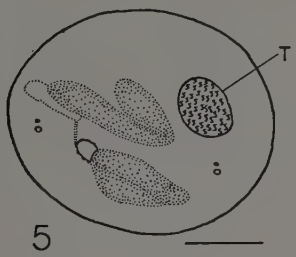
EXPLANATION OF FIGURES IN PLATE II

5. *Protogynella blarinae*. Transverse section of sixth proglottid. Scale has value of 25 microns.
6. *P. blarinae*. Transverse section of ninth proglottid. Scale has value of 25 microns.
7. *P. blarinae*. Transverse section of twelfth proglottid. Scale has value of 25 microns.
8. *P. blarinae*. Transverse section of thirteenth proglottid. Scale has value of 25 microns.
9. *P. blarinae*. Transverse section of fourteenth proglottid. Scale has value of 25 microns.
10. *P. pauciova*. Transverse section of fourth proglottid. Scale has value of 25 microns.
11. Egg of *P. pauciova*. Scale has value of 20 microns.
12. Egg of *P. blarinae*. Scale has value of 20 microns.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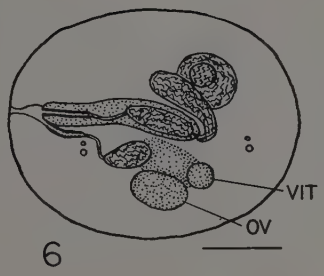
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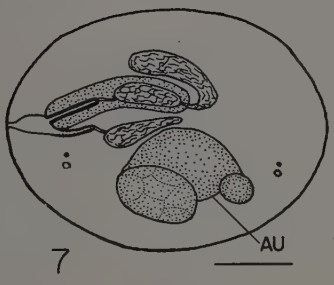
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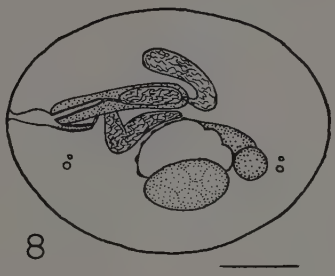
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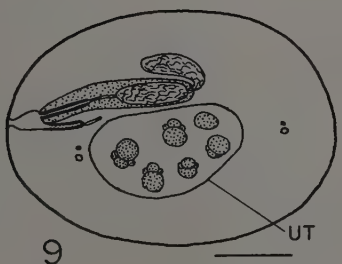
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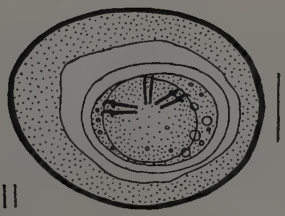
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there are approximately twenty eggs in each proglottid. The presence or absence of polar filaments on the inner egg membrane could not be ascertained.

The observations on the various forms of *Protogynella* are summarized in table 1. Two conclusions are possible from the data which have been presented. Either *Protogynella blarinae* is quite variable in several aspects which are commonly used taxonomically, or the genus contains a number of distinct species. The presence or absence of polar filaments in the eggs, the presence or absence of spines on the cirrus, and the position of the genital pores are all clear-cut taxonomic characters. The number of rostellar hooks and the number of eggs per proglottid might be attributed to normal variation, but in each case they are correlated with other characters. The shape of the hooks does not vary significantly from group to group. However, in those specimens in which the number of hooks is approximately 100 or less, they occur in a single row around the rostellum. In the specimens with approximately 250 hooks, the hooks are arranged in several overlapping rows or tiers. These data would seem to indicate that the genotype of the various groups is different.

TABLE 1

Comparison of the variation in morphology of Protogynella

	SPECIES OF *Protogynella*			
	P. blarinae Jones, 1943	*P. pauciova* n. sp. provis.	*Protogynella* sp.	*Protogynella* sp.
Host	*Blarina brevicauda*	*Blarina brevicauda*	*Sorex vagrans*	*Sorex cinereus*
Locality	Virginia and Ohio	Ohio	Oregon	Wisconsin
No. Eggs/Proglottid	6 to 8	2	6 to 8	circa 20
Polar Filaments	Present	Absent	?	?
Cirrus	Aspinose	Spinose	Spinose	Spinose
Genital Pores	Dextral	Sinistral	Dextral	Sinistral
Number of Hooks	circa 250	circa 250	circa 100	circa 80
Disposition of Hooks	2 or 3 overlapping rows	2 or 3 overlapping rows	single row	single row

Because of the lack of suitable material to complete a thorough study of *Protogynella* from Wisconsin and Oregon, the status of these forms must be left unsettled at this time. It is hoped that the present study will prompt the collection of suitable material and a thorough study of specimens from other geographical locations. Since the specimens from Franklin Co. have been studied in some detail, a description of them will be included as a step in the final settling of the status of the genus *Protogynella*. The name *Protogynella pauciova* is provisionally proposed for these specimens

Protogynella pauciova n. sp. provis.
(Figures 3, 4, 10 and 11)

Diagnosis: Total length 535 to 772 μ; greatest width, 122 to 142 μ. Scolex roughly spherical, 225 to 345 μ in diameter; accurate determination of shape and size of scolex impossible because of distortion. Scolex with four muscular, unarmed suckers; suckers 77 to 92 μ in diameter. A muscular, armed, protrusible rostellum, 45 to 48 μ in diameter and 31 to 35 μ long, located in a rostellar sac 112 to 122 μ long and 70 to 75 μ in diameter. Rostellar hooks approximately 250 in number, about 5 μ long; located in several overlapping rows. Strobila slightly flattened dorso-ventrally; about same width along entire length; edges of strobila not serrate. Proglottids 15 to 19 in number; wider than long; not well marked off externally. A single layer of longitudinal muscle fibers. Genital pores unilateral

and sinistral. Excretory system composed of two pairs of slightly undulating longitudinal canals passing ventrally to genital ducts; canals without transverse connectives; ventral canal 2.7 μ in diameter; dorsal canal 0.9 μ in diameter. Testis single, compact, and ovoid; located dorsal and aporal to sagittal plane. Testis attains maximum size in fourth or fifth proglottid, 20.0 to 23.4 μ in transverse width and 10.3 to 15.1 μ in length; fully spent and no longer evident within one or two proglottids after reaching maximum size. Cirrus sac cylindrical, 47 to 58 μ long and 9 to 10 μ in diameter; located in median frontal plane and extending from genital atrium to mid-line of proglottid. Cirrus 23 μ long and 2.7 μ in diameter; armed with minute spines. An internal seminal vesicle, 23 to 25 μ long, occupies aporal end of cirrus sac. External seminal vesicle elongate and pyriform, recurved porad dorsal to cirrus sac. Vagina located dorsal and poral to ovary, about 1.4 μ in diameter and lined with cuticle for 15 to 20 μ of its length; cuticular lining provided with minute papillae. Ovary ovoid with long axis transverse; located ventral in median sagittal plane; maximum size, reached in eighth or ninth proglottid, 14 by 20 μ. Vitellarium spheroid; located dorsal and aporal to ovary and slightly ventral to median frontal plane; largest diameter, approximately 14 μ, reached in eighth or ninth proglottid. Uterus sac-like and transverse, taking up most of gravid proglottid except region of cirrus sac and vagina, which are pushed dorsally and persist in all proglottids. Each of three terminal uteri with two fully embryonated eggs surrounded by membranes; usually a terminal proglottid devoid of eggs. Eggs ovoid, 69.1 to 87.9 (av. 79.1) μ by 53.4 to 65.9 (av. 61.9) μ. Three egg membranes present; outer membrane thin and roughly pitted; middle membrane granular, irregular, much thicker than outer membrane; inner membrane 2.0 μ thick, hyaline, without polar thickenings or filaments. Larval hooks 13 to 15 μ long.

Host: *Blarina b. brevicauda* (Say)
Locality: Franklin Co., Ohio.
Habitat: Small intestine.
Life Cycle: Unknown.
Type: A slide bearing a whole specimen has been deposited in the Helminthological Collection of the U. S. National Museum, No. 49493.

Protogynella pauciova can be differentiated readily from *P. blarinae* by the number of eggs in gravid proglottids; the former possesses only two eggs per proglottid while the latter possesses six to eight per proglottid. The eggs of *P. pauciova* are larger than those of *P. blarinae* which is probably correlated with the smaller number of eggs. Polar filaments are present in the eggs of *P. blarinae* and absent in *P. pauciova*. Other differences include the position of the genital pores, which are dextral in *P. blarinae* and sinistral in *P. pauciova*, and the possession of aspinose cirri in *P. blarinae* and spinose cirri in *P. pauciova*.

SUMMARY

The genus *Protogynella* Jones, 1943 has been emended to conform to the facts which are now known of the morphology of this genus of cestodes. The rostellum in this genus, originally described as unarmed, is actually armed with a large but variable number of minute hooks. The protogynous development originally described for this genus was a misinterpretation, and normal androgenous development found in most cestodes has been documented. *P. blarinae* Jones, 1943 is redescribed in the light of these new facts, and a provisional new species, *P. pauciova*, is described. Morphological variation within the genus is discussed.

ACKNOWLEDGMENTS

The writer wishes to express his appreciation to Dr. A. W. Jones, Department of Zoology and Entomology, University of Tennessee, Knoxville, for the loan of

paratype specimens of *P. blarinae* and for allowing the inclusion of observations made by Dr. Jones on the morphology of the rostellum of *Protogynella*. Dr. Robert Rausch, U. S. Public Health Service, Anchorage, Alaska furnished the specimens of *Protogynella* from Wisconsin and Oregon shrews, and in addition has been very helpful in pointing out the possible significance of the morphological variations which occur in this genus. Mr. Clyde Senger, Montana State College, Bozeman, has also provided the writer with specimens of *Protogynella* from the western part of the United States, and Dr. E. W. Price, U. S. Bureau of Animal Industry, graciously arranged for the loan of the type specimen of *P. blarinae*. Lastly, the writer wishes to express his gratitude to Dr. Joseph N. Miller, Department of Zoology and Entomology, the Ohio State University, for the many helpful suggestions and criticisms given during the course of this work.

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Rausch, R., and **M. L. Kuns.** 1950. Studies on some North American shrew cestodes. Jour. Parasit. 36: 443–438.

Isotope Geology. *Kalervo Rankama.* McGraw-Hill Book Company, New York. 1954. xvi+535 pp. $12.00.

While the author presently occupies a position as Research Professor of Mineral Chemistry at the University of Helsinki, he is well known in the United States, having been associated with the University of Chicago within recent years. He has coined the expression "isotope geology" to cover the applications of nuclear research to "geology," without restraint as to what can be included under this term. In fact, he includes illustrations involving geochemistry, geophysics, mineralogy, crystallography, petrology, petrography, paleoclimatology, stratigraphy, and even certain aspects of biophysics and biochemistry for the purpose of interrelating the earth sciences to recently acquired knowledge in chemistry and physics.

The first part of the book, "Physics and Chemistry of Nuclides," discusses the concepts of radioactivity, analytical methods for determination of isotopes, nuclear reactions, and applications of radioactivity to the solution of geological problems. These first ten chapters consider fundamental principles and general applications that are discussed more specifically in the second part, where extensive data are supplied as well as interpretations and conclusions.

Part II, "Natural Science of Nuclides," devotes separate chapters to the natural isotopes, their abundance, the possibility of fractionation by biochemical or geochemical processes, the use of the unstable isotopes for determination of age, etc. This part (pages 151–426) comprises chapters 11–91. Short-lived, artificial isotopes, such as 30p, are not considered in detail because of the limitations of the treatment, but certain heavy isotopes, such as those of Am and Cm, are mentioned because of their possible existence in uranium minerals.

Two appendices (numerical constants and conversion factors and international atomic weights for 1953), a bibliography (pages 433–477), an index of authors, and a subject index (pages 489–535) complete the book.

Considering the newness of the background of knowledge which forms the basis for this book, it becomes almost impossible to obtain an appraisal within a true perspective. Thus the reviewer—like the author—can merely approach the subject "with an unprejudiced mind," and assume that, regardless of minor flaws in the data and the consequent possibility of need for revision of tentative conclusions, the author has performed an outstanding service for scientists in general, but particularly those concerned with earth sciences. The publishers are to be commended for the quality of the materials and workmanship that have gone into this book, at the same time holding the price within reason for a work of this scope.

DUNCAN MCCONNELL

A PRELIMINARY NOTE ON SOME NUTRITIONAL REQUIREMENTS FOR REPRODUCTION IN FEMALE *AEDES AEGYPTI*[1]

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Department of Zoology and Entomology, The Ohio State University, Columbus 10

In a previous paper, Lea *et al.* (1955) reported that a high level of egg production resulted if *Aedes aegypti* females were fed either citrated blood or skimmed milk from a cotton pad. It was necessary to mix honey with the blood or milk as an attractant to induce feeding, and the most satisfactory ratio of honey to blood or milk was found to be 1:9. Best results were obtained if the mixture was heated to about 100° F before being absorbed on a cotton pad for feeding.

Because of the excellent results obtained when milk was substituted for the blood-meal, the writers attempted to find other proteinaceous materials which would stimulate oviposition in *Aedes*. It was subsequently found that a number of proteins, both plant and animal, when mixed with honey and presented to the mosquitoes on cotton pads, would meet the nutritional requirements for egg production. Among the materials which proved to be successful were human serum albumin, human gamma-globulin, hemoglobin, egg albumin, pepsin, lipase, trypsin, proteose-peptone, and the enzymatic hydrolysates of lactalbumin, casein, soybean meal, and yeast. These results are fully reported by Lea *et al.* (in press). It might also be mentioned here, that skimmed milk, egg albumin, and proteose-peptone were fed to *Anopheles quadrimaculatus*, and eggs were obtained in all three cases. No further work with this species has been done, however.

The success with the various proteins, and particularly with the protein hydrolysates, led to the hope that oviposition might occur if the mosquitoes were fed a mixture of amino acids, and that it might thus be possible to determine the basic nutritional requirements for reproduction in *Aedes* females.

The importance of the amino acid isoleucine had already been established in studies by the writers. A mixture of 5 g. of beef hemoglobin (Difco) made up to 100 ml. with 10 percent honey water, when fed on a cotton pad daily to a group of 200 female *Aedes*, resulted in the deposition of 16 eggs in 21 days. However, a group of 200 mosquitoes fed the same mixture but with 1.5 g. of DL-isoleucine added, laid over 6,000 eggs in the same period.

These results confirmed the work of Greenberg (1951) who fed *Aedes aegypti* a number of protein materials through a membrane, but could only induce the insects to feed if washed erythrocytes were present in the food preparation. While egg production with a suspension of sheep erythrocytes alone was low, the addition of several proteins raised considerably the number of eggs produced. In testing amino acids, he found that isoleucine, when added to the erythrocyte suspension, also increased egg production, however, the addition of a mixture of 9 other amino acids caused no increase.

It is significant to note that Block and Bolling (1951) have reported that both beef and sheep hemoglobins contain relatively low levels of isoleucine as compared to other hemoglobins and proteins in general. Otherwise hemoglobin appears to contain the normal complement of amino acids.

[1]This work has been aided by a research grant from the National Institutes of Health, Department of Health, Education, and Welfare through The Ohio State University Research Foundation, Columbus, Ohio.

It may be suggested from these results that the addition of proteins containing isoleucine or of isoleucine itself to the sheep erythrocytes or beef hemoglobin corrected a deficiency in this amino acid, and that only a medium containing more than a certain minimum level of isoleucine would result in a high level of egg production from *Aedes aegypti*. Orten, *et al.* (1945) have shown that purified beef or human globin fails to support growth in the rat unless isoleucine is added.

The importance of the amino acid tryptophane was also demonstrated in further tests. While an enzymatic hydrolysate of casein (Difco Casitone) produced a relatively large number of eggs, the acid hydrolysate of casein (Difco Casamino Acids, Technical) produced none. Since acid hydrolysis destroys tryptophane, tests were run with the acid digest fortified with this amino acid and abundant oviposition resulted.

TABLE 1

Amino acid composition in grams per 100 ml. of several experimental media. The total egg production from 500 females after nine days is given for each medium.

Amino acids	Medium number					
	1	2	3	4	5	6
L-Arginine	0.50	0.50	0.50	2.50	5.00	.....
L-Alanine	0.60	0.55	....	.....	.....	.....
L-Aspartic acid	1.00	0.60	....	.....	.....	.....
L-Cystine	0.20	0.04	0.20	.....	.....	.....
L-Glutamic acid	1.00	2.33	1.00	.....	.....	.....
Glycine anhydride	0.50	0.05	0.50	.....	.....	4.50
L-Histidine mono HCl	0.70	0.21	0.70	0.20	.....	.....
DL-Isoleucine	1.00	0.63	1.00	0.50	.....	.....
DL-Leucine	2.00	1.00	2.00	0.50	.....	.....
L-Lysine mono HCl	0.90	0.90	0.90	0.50	.....	.....
L-Methionine	0.20	0.34	0.20	1.50	.....	.....
DL-Phenylalanine	0.70	0.50	0.70	0.80	.....	.....
L-Proline	0.50	0.50	....	.....	.....	4.50
DL-Serine	0.20	0.77	....	.....	.....	.....
DL-Threonine	0.80	0.38	0.80	0.50	.....	.....
L-Tryptophane	0.40	0.12	0.40	1.00	1.00	1.00
L-Tyrosine	0.40	0.67	....	.....	.....	.....
DL-Valine	1.00	0.65	1.00	2.00	5.00	.....
Total wt.	12.60	10.74	9.90	10.00	11.00	10.00
Total eggs	2,600	1,600	2,000	29	0	0

In looking over the amino acid composition of several proteins which had successfully produced eggs, the writers noted that 18 acids were present in most of the proteins in fairly large amounts. A solution of these amino acids was made in 10 percent honey water, and this formulation was fed daily on cotton pads to a group of 500 newly emerged female mosquitoes. Several trials were made with the same amino acids but with variations in their concentrations. To date, the most productive mixtures of 18 acids are Media 1 and 2 as given in table 1. Medium 1 contains the amino acids in the proportions which are reported to be present in blood; Medium 2 was prepared on the basis of the amino acid content of casein.

Tests with the above mixtures and similar groups of 18 amino acids have indicated that a combination of levulose and dextrose (5 g. of each in 100 ml. of medium) can be substituted for honey as an attractant, thus eliminating the possibility that the honey may contribute some necessary factors to the mosquitoes.

It also appears that the addition of 0.15 g. per 100 ml. of medium of a commercially available salt mixture to the amino acid mixtures results in a moderate increase in egg production.[2]

Thus far, the effect of adding cholesterol, nucleic acid, and vitamins, and the value of adjusting the pH of the amino acid solution is undetermined.

In addition to the groups of 18 amino acids, several trials have been made with smaller mixtures. A group of 13 amino acids was tried and found to produce significant numbers of eggs (table 1, Medium 3).

From a group of 10 amino acids (table 1, Medium 4) was obtained only a very few eggs, and the significance of these results must remain in doubt until they have been studied further.

Several groups of 3 or 4 amino acids were also tested (table 1, Media 5 and 6). These mixtures contained isoleucine or tryptophane, which had already been shown to be indispensible, or both of these materials, together with enough of the highly soluble amino acids, proline and glycine, to give an approximate total of 10 g. These mixtures were all unproductive.

Work is continuing in attempts to evaluate the importance of each of the amino acids and the roles played by other nutritional factors such as vitamins and minerals. It is hoped that these results will be significant additions to the knowledge of mosquito physiology.

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Brucelosis. *M. Ruiz Castenada.* La Prensa Médica Mexicana, Mexico 7, D.F. 1954. xii + 302 pp. $5.00 U. S. ($52.00 Mex. Nat.).

This volume on human brucellosis consists of eleven chapters printed on 302 pages. There are 29 figures, 19 tables and 490 references to literature cited. Following each chapter there is an English summary of the content.

The initial chapter deals with the problem of brucellosis and is followed by a discussion of the bacteriological aspects of the genus Brucella.

Two chapters are devoted to the immunologic and hematologic studies on brucellosis. This is followed by a critical study of the most useful diagnostic procedures in diagnosing brucellosis.

In the discussion on the epidemiology of the disease it is concluded that an analysis of epidemiological statistics shows a great discrepancy in the collection of data.

A lengthy chapter of this volume is devoted to the clinical symptomatology and the effect of therapy with antibiotics on the disease in humans.

A chapter is devoted to histopathology and pathogenesis and an attempt was made to summarize available information gathered from past observations as well as from recent studies of specimens obtained by biopsies. These studies were based on observations in man and laboratory animals.

A summary is presented of the actual knowledge of chemiotherapy, describing the various methods in accordance with the chromological order in which they appeared for the human.

The final chapter deals with the problem of control of human brucellosis. These controls are designed to interfere with the transmission of the infecting organism.

This volume on human brucellosis should be of interest to Spanish-speaking people working on the problem. W. G. VENZKE

RIBOFLAVIN SYNTHESIS IN CULTURES OF *PHYSARUM POLYCEPHALUM*[1]

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The Myxomycetes, of which there are probably no more than 400 species, are rather unique among the fungi in that the vegetative phase is not mycelial in the usual sense but consists of a typically fan-shaped, coenocytic, reticulated structure, the filaments of which have no rigid cell walls. This structure, the plasmodium, is capable of moving slowly about over the substratum and obtains its food by engulfing bacteria, fungus spores and other small bits of organic matter. Viewed by some as merely a large mass of naked protoplasm, the plasmodium is on the contrary a well-developed, well-coordinated organism. Myxomycete plasmodia may be pigmented or colorless, depending upon the species, and a variety of different plasmodial colors are known. Of the pigmented forms, however, the majority are some shade of yellow.

The culture of some 20 or more species of Myxomycetes upon artificial media has been reported by various workers, but by far the greatest success in so culturing has been experienced with the yellow-pigmented form, *Physarum polycephalum* Schw. Howard (1931) first reported the successful cultivation of this species, and Camp (1936) devised a moist chamber culture method which makes it possible to easily obtain relatively large quantities of plasmodium. In view of the success experienced with the cultivation of *P. polycephalum*, it is not surprising that many of the physiological studies conducted with Myxomycete plasmodia during the past two decades have been performed with this species. Seifriz and Zetzmann (1935) found that a natural pH indicator was present in this species and that the plasmodial color would change from green to reddish-range through various intermediate colors over the pH range of >8 to <1. These workers suggested that the plasmodial pigment belongs to the group of respiratory "ferments" known as flavones, lyochromes or flavins. In another study Gray (1938), working with both pigmented and non-pigmented plasmodial types, found that in pigmented plasmodia the pigment seems to be intimately associated with the fruiting process, and that in general yellow-pigmented plasmodia would form fruiting bodies (sporangia, aethalia, plasmodiocarps) only if exposed to visible light, whereas the non-pigmented species studied formed their fruiting bodies equally well in light or darkness. These general findings were subsequently substantiated by Sobels and van der Brugge (1950). It was later found (Gray, 1939) that if light intensity remained constant, time required for initiation and completion of the fruiting process varied directly with pH value over the range of pH 3.0 to 7.0; no fruiting was obtained when the liquid in moist chamber cultures was adjusted to values as high as pH 8.0.

In a more recent study (Gray, 1953) it was reported that the effect of pH on the fruiting process was not a direct one but that pH value was effective only in that it affects light absorption by the plasmodial pigment, and that the factor primarily responsible for initiation of the fruiting process is light as was initially postulated. Thus, at a pH of 3.0, the pigment absorbs far more visible light than it does at pH 6.0 and hence fruiting would be expected to occur in a shorter period of time at the lower pH value; this latter expectation was verified experimentally.

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On the basis of these observations, the important role which the yellow plasmodial pigment plays in the fruiting process seems apparent, and hence an attempt to make a more specific characterization of the pigment seemed to be indicated. For that reason the present study was initiated.

EXPERIMENTAL METHODS AND RESULTS

The Myxomycete used in this work was the L–2 strain of *Physarum polycephalum* (Gray, 1944). The organism was cultured by the moist chamber method devised by Camp (1936) at room temperature (ca. 28° C) in strong natural light.

Quantitative riboflavin analyses were made by the microbiological method of Snell and Strong (1939). For analysis of a Myxomycete culture, the entire culture (i. e., plasmodium, partially digested rolled oats, filter paper and water) was extracted with 0.1 N HCl by autoclaving for 15 min. at 15 lb. gauge pressure; the volume of the extract was then measured and aliquots of different volume were used for the determination of riboflavin content.

Since Seifriz and Zetzmann had suggested the possibility of the plasmodial pigment being a flavin and since there exists a good microbiological method for the estimation of this vitamin, the first experiment was purely qualitative and was conducted primarily to determine if the plasmodium contains this compound. Aliquots of extract from a small amount of wet, freshly cultured plasmodium were added to the basal medium of Snell and Strong in lieu of riboflavin and it was found that this extract supported growth of *Lactobacillus casei* and hence contained riboflavin. The possibility existed, however, that the riboflavin present in the plasmodium may have had its origin in the rolled oats which were fed to the organism and so a more carefully controlled experiment was then conducted.

TABLE 1

The synthesis of riboflavin in moist chamber cultures of Physarum polycephalum

Expt. *No.*	Age of culture (*days*)	Rolled oats fed (*grams*)	Riboflavin in rolled oats (*micrograms*)	Total riboflavin in culture (*micrograms*)	Riboflavin *increase* (*micrograms*)	(*percent*)
1	4	6.0	46.5	470	423.5	910
2	4	8.6	66.7	264	197.3	296
3	3	4.3	33.3	228	194.7	584

A moist chamber culture of *P. polycephalum* was started using a small piece of fresh plasmodium as inoculum. The plasmodium was fed with small portions of rolled oats at 24-hour intervals, each portion of rolled oats being carefully weighed. At the end of 4 days the entire culture was extracted and the extract used for riboflavin analysis. A similar extraction and analysis was made with finely-ground, dry rolled oats from the same source as those used as plasmodial food. The extract from the 4-day old culture was found to contain 470 μg. of riboflavin. The average riboflavin content of the dry rolled oats was found to be 7.75 μg./gm., and since a total of only 6.0 gm. of rolled oats had been fed to the plasmodium during the 4-day culture period, only 46.5 μg. of riboflavin had been introduced into the culture in rolled oats. Thus, during the culture period there was an increase in riboflavin in the culture of 423.5 μg.—an increase of approximately 910 percent. The results of this experiment as well as those obtained in two similar experiments are summarized in table 1.

DISCUSSION

On the basis of the results presented in table 1 it is obvious that relatively large amounts of riboflavin are synthesized in moist chamber cultures of *P. polycephalum* during a growth period of 3 to 4 days. The largest increase both in terms of actual amount as well as percentage was obtained in the first experiment in which 423.5 μg. representing an increase of 910 percent over the quantity supplied to the culture in rolled oats, were synthesized. The total riboflavin values reported in each experiment are very probably low and do not truly reflect the amounts actually synthesized, since the growing cultures were exposed to natural visible light for about 12 hr. out of each 24, and some of the riboflavin synthesized may have been destroyed by light, since this compound is known to be photolabile.

Thus far in the discussion it has been stated only that riboflavin was synthesized in Myxomycete cultures, and this is the only statement that can be made with certainty at this time; however, it seems highly probable that riboflavin was in fact synthesized by the plasmodium. Plasmodia cultured in moist chambers as described above are not pure cultures, and the possibility exists that compounds found in such cultures may have been synthesized by bacterial contaminants; however, when plasmodia are not overfed bacterial contamination is not great. In the experiments here reported, small quantities of rolled oats were fed and bacterial contamination was slight.

SUMMARY

Analyses of whole cultures of plasmodia of *Physarum polycephalum* have shown that relatively large quantities of riboflavin may be synthesized in such cultures. In view of the fact that rolled oats were fed to the plasmodia in small quantities with resultant low level of bacterial contamination, it seems probable that most if not all of the riboflavin was synthesized by the Myxomycete plasmodia. While it is not suggested that the yellow pigment of the plasmodium consists only of riboflavin, it seems evident that part of the yellow coloration may be due to this vitamin.

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THE VASCULAR FLORA OF CLINTON COUNTY, OHIO

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The present investigation summarizes the existing, available knowledge of the occurrence and distribution of vascular plants growing without cultivation in Clinton County, Ohio. No previous floras of this county have been published.

Field collections in Clinton County have been made by the writer from 1939 to the present time during vacations and spare time at varying intervals, the longest period of non-collecting having been from 1943 to 1946. Recent collections were made under tenure of a Muellhaupt Scholarship at the Ohio State University (see Acknowledgments). Specimens obtained by other persons have been examined in the herbaria of the Ohio State University and Wilmington College, Wilmington, Ohio. Of the total number of species found in Clinton County, about one-half have been obtained only by the present writer, the remaining one-half having been collected also or solely by other persons. The present annotated list adds many more previously unreported county distribution records to those listed by the writer in Jones (1942, 1943).

In any area new species become established, others are exterminated by man or nature, and some are unavoidably overlooked; hence, no flora is ever really complete. It is thought that this study has been continued long enough to produce a reasonably thorough account of the flora of Clinton County. The annotated list includes a total of 813 species distributed among 108 families, 411 genera, with 21 species of Pteridophytes, 1 Gymnosperm, 189 Monocotyledons, and 602 species of Dicotyledons.

DESCRIPTION OF AREA

Clinton County, in southwestern Ohio, lies within the Till Plains section of the Central Lowland (Fenneman, 1938). Its county seat, Wilmington, is about 50 mi. northeast of Cincinnati and about 60 mi. southwest of Columbus. The area of the county is about 401 sq. mi. Originally a part of the Virginia Military Survey, the county was organized in 1810, although the first settlers arrived several years before that date.

The greater part of the county is within the drainage system of the Little Miami River. The four principal streams are Anderson's Fork, Todd's Fork, Cowan's Creek, and East Fork of the Little Miami River, all of which are tributaries of the Little Miami River. Another large tributary, Caesar's Creek, crosses the extreme northwest corner of the county. That section northeast of the Reesville moraine drains east through tributaries of Rattlesnake Creek to the Scioto River system. A number of small ponds and reservoirs have been formed artificially, and a state-owned lake of 720 acres, Lake Cowan, was created in 1950–1951 by the damming of Cowan's Creek.

Topography varies from nearly level to rolling. In the more dissected western portion, local differences in elevation from valleys to adjacent uplands are rarely more than 100 ft. Elevation above sea level ranges from about 785 ft. (Austin, 1930) in the west (near Clarksville) to about 1180 ft. in the east (near New Vienna).

The surface rocks are of Silurian and Ordovician ages. The Niagara dolomite (Silurian) is present in the north and east, covering nearly two-thirds of the county. The remaining one-third is underlain by Richmond limestone (Ordovician). Forming a narrow band between these two formations is the Brassfield limestone (Silurian). These highest strata are generally rather deeply covered by a mantle

of glacial drift, and usually are visible only along streams where they have been exposed by erosion.

All of Clinton County was glaciated during Pleistocene time by the Illinoian and Wisconsin glaciations. The Illinoian, which covered all of the county, is exposed in the south. The subsequent Wisconsin glaciation extended over the northern three-fourths. The Cuba and Xenia end moraines of the Tazewell (actual substage still in doubt) substage of the Wisconsin cross the southern part of the county, and bound the Illinoian drift. In the northeast lies the Reesville end moraine of the Early Cary substage (fig. 1).

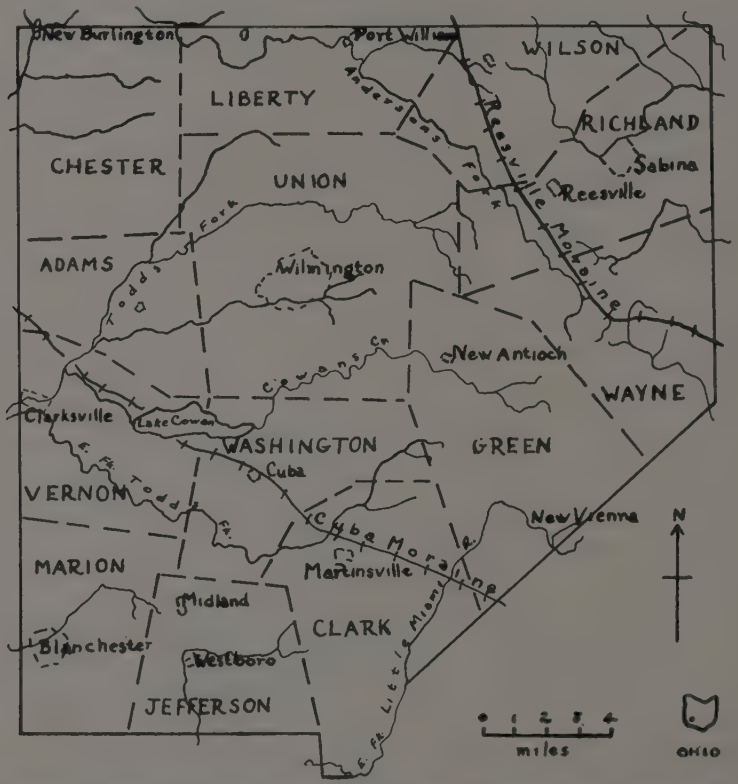

FIGURE 1. Map of Clinton County, Ohio. Areas of glacial drift: northeast—Early Cary; central—Tazewell (?); south—Illinoian. Xenia moraine and secondary moraines not shown. Locations of moraines modified from Austin (1930) and other sources.

Predominant soil types, according to a state soil survey in 1940, are: Miami, Crosby, and Brookston silt loams and silty clay loams on the Early Cary drift; Russell and Fincastle silt loams on the Tazewell drift; and Clermont and Rossmoyne silt loams on the Illinoian drift. A detailed soil survey of the county is now underway under the direction of the Division of Lands and Soils of the Ohio Department of Natural Resources.

PAST AND PRESENT VEGETATION

Judging by present vegetation and by historical accounts, Clinton County before human settlement was covered with forest, except for certain discontinuous areas in and near the valley of Anderson's Fork, where this stream parallels the Reesville moraine. These small areas were grassland of some kind, probably prairie or marsh. None of these places now are undisturbed by agricultural utilization; however, a few species of prairie plants have survived.

Of the original forest there are now no undisturbed remnants, although a few of the original trees, particularly white oaks, are still standing. The soils of the county are so fertile that agriculture on an intensive scale has replaced the forest. The largest areas of woodland now remaining occur along the steep slopes of stream valleys in the dissected western portion of the county and on the poorly-drained flats of the Illinoian till plain in the south.

According to Rothacher (1942), in a forest survey made under W. P. A. by cooperating state and national agencies, only 12,084 acres or 4.7 percent of the land area of Clinton County are forested. This acreage is distributed among 1052 separate woodlands, the average acreage per woodland being 11.5 acres. Only two woods are over 150 acres in size. Of all woodlands 68 percent are grazed by farm animals, this figure being much higher in the more intensively farmed townships, and somewhat lower in those less intensively farmed.

Present major forest types include beech-maple and mixed hardwoods on the Tazewell drift, oak-hickory and swamp forest on the Early Cary drift, and pin oak with white oak and other hardwoods on the poorly-drained Illinoian till plain. These are very general, predominating forest types; there is much local variation and many exceptions. The acreage of the six most abundant forest types is as follows (Rothacher, 1942): beech-maple—3889 acres; pin oak—2043; oak-hickory—1962; elm-ash-hard maple—1533; mixed hardwoods –1327; oak-hard maple—731.

Frequent references in the catalog have been made to the species of the Illinoian till plain. The flora of this drift area is less similar to that of much of central and western Ohio than is the flora of Wisconsin drift areas. The poorly-drained flats of the Illinoian till plain are the habitats of most of the "unusual" species; where drainage is better, the flora is more like that of the Wisconsin drift to the north. Floristic relationships and forest ecology of the Illinoian till plain have been described by Braun (1935, 1936).

COLLECTORS

Those persons, other than the present writer, who have made most of the collections from Clinton County are listed below. Following their names are the dates of their collections and the herbaria where their specimens are filed (either the Ohio State University, "O", or Wilmington College, "W").

E. Lucy Braun (1921, 1923, 1924, 1930—O; also Braun herb. and Univ. of Cincinnati herb.); Frank O. Hazard (1938—W); C. P. Ingold (1901, 1902—O); Eugene Osborn (1938—W); Rendell Rhoades (1935, 1938, 1949—W); Katie M. Roads (1915, 1926–1939—O); J. S. Vandervort (1892, 1894—O).

Others who have collected small numbers of specimens include: R. A. Adams (1949—W); A. H. Allen (1938, 1939—W); Floyd Bartley and Leslie Pontius (1932—O); Delzie Demaree (1935—O); D. L. James (1875–1877—O); Joseph F. James (1871, 1876, 1879—O); W. A. Kellerman (1894—O); C. L. Nolan (1949—W); E. Rhoades (1939—W); Alice M. Smith (1938—W); Stanley B. Stowe (1906—O); H. H. Vannorsdall (1953—O); Clara G. Weishaupt (1933, 1952—O).

EXPLANATION OF THE ANNOTATED LIST

Taxonomy and nomenclature in the annotated list follow for the most part the recent edition of Britton and Brown's *Illustrated Flora* (Gleason, 1952), with

important aid and certain additions from the recent edition of *Gray's Manual* (Fernald, 1950). Other changes were derived from recent taxonomic studies and from the work of specialists, as noted below. Nomenclature of the grasses ,is generally that of Hitchcock and Chase (1950). The *Flora of Indiana* (Deam, 1940) was helpful for general information and identification. The recent edition of Britton and Brown was followed because the broader concepts of species and infraspecific taxa (but not the illustrations) seem to the present writer more realistic than those of *Gray's Manual*, 8th edition. Synonyms are mostly from the latter work. The sequence of families, genera, and species is that of Gleason (op. cit.), which is a modification of the Engler and Prantl system. Schaffner (1932) was consulted for ranges of Ohio species, but more up-to-date information was available from records in the herbarium of Ohio State University. In the list the abbreviations, B. & B., and, G. M., refer to Gleason (op. cit.) and Fernald (op. cit.), unless other editions of these works are indicated.

Certain taxonomic groups were determined by specialists, in which case their nomenclature was adopted. These groups are: *Potamogeton*—E. C. Ogden; Juncaceae and *Carex*—F. J. Hermann; *Salix*—C. R. Ball; *Crataegus*—E. J. Palmer; *Fraxinus*—Gertrude N. Miller. As noted in the text, also, certain species of *Botrychium* and *Najas* by R. T. Clausen; certain species of grasses by J. R. Swallen.

The frequency of occurrence within the county is stated in the catalog according to the following arbitrary scale:

Rare.....1 station
Scarce.....2–3 stations
Infrequent....4–5 stations
Frequent.....6–9 stations
Common.....10 or more
Abundant....Very common, i. e., occurs nearly everywhere in suitable habitats

These designations indicate the number of known localities of occurrence of a species; they have nothing to do with the number of individual plants present at a locality. Sight records and herbarium collections are included in the frequency designations. For those species which are of restricted or local occurrence additional information may be listed: number of localities of occurrence (or stations); indicated by the number after the frequency designation; townships in which found (see accompanying map). As more than one station may exist in a township, the number of stations is not necessarily the same as the number of townships. In the case of certain species or in difficult taxonomic groups, no frequency data are listed. The abbreviation, ITP, refers to the Illinoian till plain. Initials in parentheses are those of collectors, when not the present writer.

All unbracketed species are represented by specimens examined by the present writer. The 9 species and 1 hybrid enclosed in brackets, [ ], were not examined, but the reports of their occurrence are judged to be reliable.

A number of records from Schaffner (1932) and later additions to that catalog, as well as specimens in the Ohio State University herbarium, have been excluded because of erroneus identifications, or of fragmentary material, or in the case of cultivated species which rarely escape and are doubtfully persistent.

Specimens substantiating the annotated list are located (except for species in brackets) mainly in the Ohio State University herbarium, and secondarily (mostly common species) at Wilmington College. Writer's collections are being deposited at Ohio State University to the extent of one specimen of previously unreported species, while other additional specimens will remain in his possession.

Species introduced or adventive from foreign continents are denoted by an asterisk. All others are species native to this continent, regardless of whether indigenous in the county. This practice follows *Gray's Manual*, 8th edition.

ANNOTATED LIST

PTERIDOPHYTA

Equisetaceae

Equisetum arvense L. Field Horsetail. Common along railroads and in moist places.
Equisetum hiemale L. Scouring Rush. Frequent along stream banks.

Ophioglossaceae

Botrychium dissectum Spreng. Grape Fern.
Var. *dissectum*. Infrequent in moist woods. Often occurs with following variety but is less common.
Var. *obliquum* (Muhl.) Clute. Frequent in moist woods. Determined by R. T. Clausen.
Botrychium virginianum (L.) Sw. subsp. *virginianum*. Rattlesnake Fern. Frequent in moist, rich woods. Determined by R. T. Clausen.
Ophioglossum vulgatum L. Adder's-tongue Fern. Rare: Chester. Moist woods.

Osmundaceae

Osmunda regalis L. var. *spectabilis* (Willd.) Gray. Royal Fern. Scarce: wet places in pin oak woods in ITP; near New Antioch (JSV).

Polypodiaceae

Adiantum pedatum L. Maidenhair Fern. Frequent in rich woods.
Pellaea atropurpurea (L.) Link var. *Bushii* Mack. (*P. glabella* Mett.). Smooth Cliff Brake. Scarce: Liberty. On limestone cliffs.
Onoclea sensibilis L. Sensitive Fern.. Infrequent in wet places in woods.
Asplenium platyneuron (L.) Oakes. Ebony Spleenwort. Frequent in dry or moist woods.
Camptosorus rhizophyllus (L.) Link. Walking Fern. Scarce: Liberty. On limestone cliffs.
Athyrium pycnocarpon (Spreng.) Tidestr. Narrow-leaved Spleenwort. Scarce: 3. Chester, Vernon. Moist, rich woods.
Athyrium thelypteroides (Michx.) Desv. Silvery Spleenwort. Scarce: Adams (HHV); near New Antioch (JSV). Collections are of forma *thelypteroides*.
Athyrium Filix-femina (L.) Roth var. *Michauxii* Mett. (*A. angustum* (Willd.) Presl). Lady Fern. Infrequent in moist woods, mainly in ITP.
Woodsia obtusa (Spreng.) Torr. Blunt-lobed Woodsia. Rare: Liberty. Limestone cliffs. Perhaps to be found, also, in Chester and Union Twps.
Cystopteris bulbifera (L.) Bernh. Bulblet Bladder Fern. Rare: Liberty. Limestone cliffs. Perhaps to be found, also, in Chester and Union Twps.
Cystopteris fragilis (L.) Bernh. var. *protrusa* Weatherby. Fragile Fern. Frequent in moist woods.
Thelypteris hexagonoptera (Michx.) Weatherby. (*Dryopteris hexagonoptera* (Michx.) C. Chr.). Broad Beech Fern. Scarce: Vernon—rich woods; near New Antioch (Vandervort, Kellerman).
Thelypteris palustris Schott var. *pubescens* (Lawson) Fern. Marsh Fern. Rare: Vernon (RR).
Dryopteris austriaca (Jacq.) Woynar var. *spinulosa* (O. F. Muell.) Fiori. (*D. spinulosa* (O. F. Muell.) Watt.). Spinulose Shield Fern. Rare: near New Antioch in 1894 (JSV).
Polystichum acrostichoides (Michx.) Schott. Christmas Fern. Frequent in woods; the most common fern in the dissected western part of the county.

SPERMATOPHYTA

Gymnospermae

Cupressaceae

Juniperus virginiana L. Red Cedar. Common in dry fields, thin woods, and along fence-rows.

Angiospermae

Monocotyledoneae

Typhaceae

Typha latifolia L. Common Cat-tail. Frequent in wet places.
Typha angustifolia L. Narrow-leaved Cat-tail. Rare: Jefferson. Wet area along railroad.

Najadaceae

Potomogeton nodosus Poir. Rare: Washington. Lake Cowan.
Potomogeton foliosus Raf.
Var. *foliosus*. In three streams in north and central parts.
Var. *macellus* Fern. Richland. In pond in abandoned quarry at Melvin.
Najas gracillima (A. Br.) Magnus. Rare: Washington. Present in north part of Lake Cowan in enormous numbers in autumn, 1953. Determined by R. T. Clausen.

Alismaceae

Alisma subcordatum Raf. Water Plantain. Frequent in wet places.
Sagittaria latifolia Willd. Arrowhead. Common in wet places. Collections include at least two named forms.

Gramineae

**Bromus tectorum* L. Downy Chess. Common in waste places and along roadsides; often very abundant where found.
**Bromus inermis* Leyss. Hungarian Brome Grass. Infrequent along roadsides.
Bromus pubescens Muhl. ex Willd. (*B. purgans* L. f. *laevivaginatus* Wieg.). (cf. Wagnon, 1952). Scarce: 2. Vernon, Chester. Dry oak woods; moist beech-maple-white oak woods.
**Bromus commutatus* Schrad. var. *apricorum* Simonkai. Vernon. Dry hillside. Det. by J. R. Swallen.
**Bromus japonicus* Thunb. Apparently, rapidly increasing in abundance in fields and waste places. Two collections det. by J. R. Swallen.
**Festuca elatior* L. Meadow Fescue. Infrequent in woodland pastures and along roadsides.
Festuca obtusa Biehler. Nodding Fescue. Scarce: 3. Vernon, Chester. Moist, rich woods. Det. by J. R. Swallen.
Glyceria striata (Lam.) Hitchc. Infrequent in wet places.
**Poa annua* L. Annual Bluegrass. Frequent in lawns and waste places.
**Poa compressa* L. Canada Bluegrass. Common in a variety of habitats, especially in dry open woods.
**Poa pratensis* L. Kentucky Bluegrass. Abundant in moist and dry woods, pastures, and waste places.
Poa sylvestris Gray. Scarce: 2. Vernon, Liberty. Dry wooded hillside; dry ledges of limestone. Det. by J. R. Swallen.
Eragrostis hypnoides (Lam.) BSP. Scarce: 2. Liberty, Jefferson. Muddy banks of streams.
Eragrostis spectabilis (Pursh) Steud. (*E. pectinacea* (Michx.) Steud.), Purple Lovegrass. Infrequent along roadsides and in fields.
Eragrostis Frankii C. A. Meyer. Scarce: Liberty. Moist, open bottomland. Also at unknown loc. (KMR).
Eragrostis pectinacea (Michx.) Nees. Frequent along roadsides and in waste places. Det. by J. R. Swallen.
Eragrostis capillaris (L.) Nees. Scarce: 3. Liberty. Dry, rocky hillside. Near New Vienna (CPI). Richland. In corn field. The last collection det. by J. R. Swallen.
**Eragrostis cilianensis* (All.) Lutati (*E. megastachya* (Koel.) Link). Common weed in gardens and waste places.
**Dactylis glomerata* L. Orchard Grass. Abundant in permanent pastures, fields, and waste places.
Triodia flava (L.) Smyth. Purple-top. Common along roadsides and in waste places.
**Agropyron repens* (L.) Beauv. Quack Grass. Infrequent along roadsides and in waste places.
Elymus villosus Muhl. Infrequent to frequent in woods and thickets.
Elymus riparius Wieg. Infrequent to frequent in moist places and along streams. One collection det. by J. R. Swallen.
Elymus virginicus L. Frequent in woods and waste places.
Hystrix patula Moench. Bottle-brush Grass. Frequent in dry woods, usually along streams in rocky or gravelly places.
Hordeum jubatum L. Squirreltail Grass. Rare: roadside in Union Twp.
**Lolium multiflorum* Lam. Italian Rye Grass. Rare: along railroad near New Vienna (KMR).
Sphenopholis intermedia (Rydb.) Rydb. Scarce: 2. Chester, Liberty. Moist, level woods; dry soil on limestone outcrop.
**Avena sativa* L. Oats. Occasional, along railroads and roadsides.
**Arrhenatherum elatius* (L.) Mert. & Koch. Oat-grass. Rare: "along a road near New Vienna" (KMR).
Danthonia spicata (L.) Beauv. Poverty-grass. Common in stony, overgrazed pastures, dry oak woods, and similar places.
Calamagrostis canadensis (Michx.) Beauv. Blue-joint. Rare: Jefferson. Clay bank along railroad.
Agrostis stolonifera L. var. *major* (Gaud.) Farw. (*A. alba* L.). Red-top. Infrequent in moist fields and along roadsides.
Agrostis Elliottiana Schult. Rare: Vernon. Moist pasture in ITP.
Agrostis perennans (Walt.) Tuckerm. Upland Bent. Frequent in moist or dry woods and in rocky places. Quite variable. One specimen det. by J. R. Swallen.
Cinna arundinacea L. Wood Reed Grass. Common in moist woods, especially in ITP.
**Phleum pratense* L. Timothy. Frequent in waste places.
Muhlenbergia Schreberi Gmel. Common in fields, open woods, and waste places.
Muhlenbergia sobolifera (Muhl.) Trin. Rare: Liberty. Dry soil over limestone outcrop.

Muhlenbergia frondosa (Poir.) Fern. Infrequent in moist or wet places. One specimen det. by J. R. Swallen.

Sporobolus asper (Michx.) Kunth. Infrequent weed along railroads and roadsides; seen only in southern half of county.

Sporobolus vaginiflorus (Torr.) Wood. Scarce: 2. Along railroads in Wilmington and near New Vienna (KMR).

Sporobolus neglectus Nash. Rare: Wilson. Moist bank of Anderson's Fork in area which was probably once prairie or marsh.

Brachyelytrum erectum (Schreb.) Beauv. Rare: Vernon. Dry oak woods.

Aristida dichotoma Michx. At unknown locality (KMR).

Aristida longespica Poir. Infrequent in poorly-drained fields and waste places in ITP. Often abundant where found and probably common within ITP.

Aristida oligantha Michx. Infrequent in fields and along railroads; seen only in southern half of county.

**Eleusine indica* (L.) Gaertn. Goose Grass. Frequent weed in waste places.

Spartina pectinata Link. (*S. Michauxiana* Hitchc.). Prairie Cordgrass, Slough Grass. Scarce: 2. Wilson. In drainage ditch; roadside ditch; both stations in probable former prairie or marsh.

Hierochloe odorata (L.) Beauv. Sweet Grass. Rare: near Blanchester in 1921 (ELB).

**Anthoxanthum odoratum* L. Sweet Vernal Grass. Rare: near Blanchester in 1927 (KMR).

Phalaris arundinacea L. Reed Canary Grass. Scarce to infrequent along roadsides.

Var. *picta* L. Ribbon Grass. This cultivated variety found along railroad near New Vienna (KMR).

Leersia oryzoides (L.) Sw. Rice Cutgrass. Frequent in moist or wet places.

Leersia virginica Willd. Whitegrass. Common in moist places, especially along streams.

**Digitaria sanguinalis* (L.) Scop. Crabgrass. Frequent to common in waste places.

**Digitaria Ischaemum* (Schreb.) Muhl. Small Crabgrass. Infrequent to frequent in waste places.

Paspalum laeve Michx. Rare: Vernon. Clearing in ITP. Det. by J. R. Swallen.

Paspalum pubescens Muhl. Scarce: 3. Union, Chester, Vernon. Pastures, open woods, moist clearings. One specimen det. by J. R. Swallen.

**Panicum miliaceum* L. Broomcorn Millet. Rare: near New Vienna (KMR).

Panicum flexile (Gatt.) Scribn. Scarce: collected twice by Katie M. Roads, including once in "low place near Cuba".

Panicum capillare L. Witchgrass. Common in corn fields, along roadsides, and in waste places. One specimen det. by J. R. Swallen.

Panicum Gattingeri Nash. Rare: Vernon. Moist, sandy place along stream. Det. by J. R. Swallen.

Panicum dichotomiflorum Michx. Common in corn fields and waste places.

Panicum agrostoides Spreng. Scarce: 2. Wilson, Marion. Along railroad; swampy open place in ITP.

Panicum stipitatum Nash. Rare: Jefferson. Drainage ditch in ITP.

Panicum virgatum L. Switchgrass. Infrequent along railroads and roadsides.

Panicum depauperatum Muhl. Rare: Liberty. Dry soil over limestone outcrop.

Panicum linearifolium Scribn. Rare: Vernon. Dry, rocky, open slope.

Panicum implicatum Scribn. Rare: Liberty. Dry soil on limestone ledges. Det. by J. R. Swallen.

Panicum huachucae Ashe (incl. var. *fasciculatum* (Torr.) Hubb.). Scarce to infrequent in woods. One collection (Richland Twp.) det. by J. R. Swallen as var. *fasciculatum*.

Panicum polyanthes Schult. Rare: Jefferson. Poorly-drained pin oak woods in ITP.

Panicum clandestinum L. Infrequent in ditches and along railroads, mainly in ITP. One specimen det. by J. R. Swallen.

Panicum latifolium L. Richland—along railroad. Det. by J. R. Swallen.

Panicum Boscii Poir. (incl. var. *molle* (Vasey) Hitchc. & Ch.). Infrequent in woods.

Panicum microcarpon Muhl. Scarce: 3. Marion, Jefferson. In swampy, pin oak woods of the ITP. Probably, common and characteristic within the ITP.

Panicum dichotomum L. Scarce: Vernon. Dry, open woods, with oaks or mixed hardwoods.

**Echinochloa crusgalli* (L.) Beauv. (incl. *E. pungens*)Poir.) Rydb.). Barnyard Grass. Abundant in all sorts of waste places. One collection is *E. pungens*; it grew with *E. crusgalli*. Det. by J. R. Swallen.

**Setaria glauca* (L.) Beauv. (*S. lutescens* (Weigel) Hubb.). Yellow Foxtail Grass. Abundant in waste places.

**Setaria viridis* (L.) Beauv. Green Foxtail Grass. Abundant in waste places.

**Setaria Faberii* Herrm. Giant Foxtail Grass. Frequent in corn fields, along roadsides, and in other waste places. Apparently becoming more common. Det. by J. R. Swallen.

Cenchrus pauciflorus Benth. (sensu B. & B., & Hitchc. & Chase). Sandbur. Rare: along railroad near New Vienna in 1937 (KMR).

Andropogon scoparius Michx. Little Bluestem. Scarce: 2. Jefferson, Liberty. Along railroad (glaucous form); dry opening over limestone.

Andropogon Gerardi Vitm. (*A. furcatus* Muhl.). Big Bluestem. Scarce: 3. Union: roadside and a railroad near Melvin, appearing to be a prairie remnant at former place. Near New Vienna (KMR).
Andropogon virginicus L. Broomsedge. Abundant in fields, along roadsides, and in waste places.
**Sorghum halepense* (L.) Pers. Johnson Grass. Frequent in waste places, and along roadsides ahd railroads, especially in southern part of county.
Sorghastrum nutans (L.) Nash. Indian Grass. Rare: Jefferson. Along railroad.

Cyperaceae

Cyperus flavescens L. Rare: near Cuba in 1934 (KMR). Specimen det. by H. T. O'Neill.
Cyperus rivularis Kunth. Scarce: 2. Vernon, Liberty. Moist, sand bar; open bottomland.
Cyperus strigosus L. Frequent in moist places.
Cyperus esculentus L. Frequent in moist places.
Eleocharis obtusa (Willd.) Schult. Frequent in wet places, especially around Lake Cowan and in ITP.
Eleocharis Smallii Britt. Liberty, Washington. In wet places.
Eleocharis calva Torr. Washington. Shore of Lake Cowan.
Scirpus Purshianus Fern. (*S. debilis* Pursh). Rare: Washington. Mud flat on north shore of Lake Cowan. Determined by F. J. Hermann.
Scirpus validus Vahl. Great Bulrush. Frequent in wet places.
Scirpus fluviatilis (Torr.) Gray. River Bulrush. Rare: Washington. Mud flat on north shore of Lake Cowan.
Scirpus cyperinus (L.) Kunth. (sens. str.). Frequent in wet places.
Scirpus atrovirens Muhl. Frequent in wet places.
Scirpus lineatus Michx. Infrequent in wet places.
Carex cephalophora Muhl. Frequent in moist or dry woods.
Carex rosea Schkuhr. Union. In moist woods.
Carex convoluta Mack. Vernon. In oak woods.
Carex gravida Bailey. Union. In open woods.
Carex sparganioides Muhl. Locality unknown (CPI). Also, Vernon. In wooded bottomland.
Carex vulpinoidea Michx. Fox Sedge. Common in moist places.
Carex stipata Muhl. Vernon. In ITP in pin oak woods and adjacent swampy clearing.
Carex conjuncta Boott. Frequent in woods.
Carex scoparia Schkuhr. Jefferson. In wet place in ITP.
Carex cristatella Britt. Collected in three generally-distributed localities in moist woods.
Carex normalis Mack. Union. In open woods.
Carex Willdenovii Schkuhr. Vernon. Dry slope in oak woods.
Carex Jamesii Schwein. Three localities in Clark and Vernon Twps. in moist woods.
Carex artitecta Mack. Chester, Vernon. Wooded slopes.
Carex communis Bailey. Chester. Dry hillside.
Carex hirtifolia Mack. Frequent in moist woods.
Carex laxiculmis Schwein. var. *copulata* (Bailey) Fern. Clark. In moist, rich woods.
Carex albursina Sheldon. Frequent, mainly in wooded ravines of beech-maple in western half of county.
Carex blanda Dewey. Infrequent in moist woods.
Carex gracilescens Steud. Marion. Pin oak woods.
Carex Haleana Olney. Adams, Chester. Around spring; moist, level woods of elm-ash.
Carex oligocarpa Schkuhr. Union. Moist, rich woods.
Carex Hitchcockiana Dewey. Chester. Wooded slope.
Carex amphibola Steud. var. *turgida* Fern. Union. Moist, open woods.
Carex gracillima Schwein. Vernon. In swampy place in ITP.
Carex Davisii Schwein. & Torr. Frequent in wet or moist woods, including wooded bottomlands.
Carex Swanii (Fern.) Mack. Jefferson, Chester. In poorly-drained woods.
Carex hirsutella Mack. Frequent in moist woods.
Carex caroliniana Schwein. Jefferson. In poorly-drained, white oak woods in ITP.
Carex Shortiana Dewey. Frequent in moist places.
Carex crinita Lam. Marion. In wet places.
Carex Frankii Kunth. Frequent in wet places.
Carex squarrosa L. Frequent in poorly-drained woods and wet places, mainly in ITP.
Carex typhina Michx. Jefferson. In poorly-drained woods in ITP.
Carex lurida Wahl. Union. Along small stream.
Carex Grayii Carey. Frequent in poorly-drained woods, mainly in ITP.
Carex lupulina Muhl. Union in 1871 (JFJ); Marion—wet place.

Araceae

Arisaema triphyllum (L.) Schott var. *triphyllum*. Jack-in-the-Pulpit. Common in moist, rich woods.

Arisaema Dracontium (L.) Schott. Green Dragon. Infrequent in ravines and moist woods.
Symplocarpus foetidus (L.) Nutt. Skunk Cabbage. Rare: Adams. In seepage area around spring at base of "Bunker Hill" (first found by FOH).
Acorus Calamus L. Sweetflag, Calamus. Infrequent in wet places and along small streams.

Lemnaceae

Lemna minor L. Common Duckweed. Infrequent in streams and artificial ponds; Lake Cowan.

Commelinaceae

Tradescantia subaspera Ker. var. *subaspera*. (*T. pilosa* Lehm.). Zigzag Spiderwort. Scarce: 2. Vernon, Washington. Dry, rocky, wooded slope; moist bottomland.
Tradescantia virginiana L. Virginia Spiderwort. Scarce: 3. Vernon, Richland. Dry, rocky, wooded slope; moist woods.
**Commelina communis* L. Dayflower. Frequent in waste places.

Juncaceae

Juncus effusus L. var. *solutus* Fern. & Wieg. Frequent in wet places.
Juncus tenuis Willd. (*J. macer* S. F. Gray). Path Rush.
Var. *tenuis*. Abundant in fields and permanent pastures, open woods, and waste places. Forma *anthelatus* (Wieg.) Hermann in pin oak woods in Jefferson Twp.
Var. *Dudleyi* (Wieg.) Hermann. (*J. Dudleyi* Wieg.). Scarce: 3. Union, Richland. Along railroads in wet places.
Juncus biflorus Ell. Scarce: 3. Vernon, Chester; near New Vienna (KMR). Swampy clearing in ITP; abandoned field; along railroad.
Juncus Torreyi Cov. Frequent in wet places, usually along railroads or along small streams.
Juncus brachycarpus Engelm. Scarce: 3. Jefferson, Vernon. Wet places in clearings in ITP. Probably not uncommon within ITP.
Juncus acuminatus Michx. Scarce: Jefferson, Marion. Wet places in ITP.
Luzula echinata (Small) Hermann. Wood Rush. Infrequent: dry, wooded hillsides and moist woods in southern and western parts of county.

Liliaceae

**Hemerocallis fulva* L. Tawny Day-lily. Common along roadsides.
Allium tricoccum Ait. Wild Leek. Common in moist, rich woods.
**Allium vineale* L. Field Garlic. Locally abundant along roadsides and in waste places.
Allium canadense L. Wild Garlic. Frequent in moist woods.
Lilium canadense L. Canada Lily. Frequent: Chester, Wilson, Richland, Vernon, Jefferson. In moist or wet woods.
Erythronium americanum Ker. Yellow Adder's-tongue, Trout Lily, Dog-tooth Violet. Abundant in moist, rich woods.
Erythronium albidum Nutt. var. *albidum*. White Adder's-tongue. Frequent in moist, rich woods.
Camassia scilloides (Raf.) Cory. Wild Hyacinth. Infrequent to frequent in moist, rich woods.
**Ornithogalum umbellatum* L. Star-of-Bethlehem. Occasional in waste places and open woods.
**Asparagus officinalis* L. Common Asparagus. Common along roadsides, open woods, and waste places.
Smilacina racemosa (L.) Desf. False Solomon's Seal. Abundant in moist, rich woods.
Smilacina stellata (L.) Desf. Starry False Solomon's Seal. Rare: Richland. In ditch along railroad.
Uvularia grandiflora Sm. Large Bellwort. Frequent in moist, rich woods.
Polygonatum canaliculatum (Muhl.) Pursh (sensu B. &. B.). Scarce to infrequent in woods.
Polygonatum biflorum (Walt.) Ell. (sensu B. & B.). True Solomon's Seal. Frequent in moist, rich woods.
Trillium sessile L. Sessile Trillium. Common in moist woods.
Trillium grandiflorum (Michx.) Salisb. Large-flowered Trillium. Common in moist, rich woods.
Trillium Gleasoni Fern. (*T. declinatum* (Gray) Gleason; *T. flexipes* Raf.). Rare: Richland. In poorly-drained woods of elm-ash-silver maple-red maple. In this population, flower color varies from white to red-purple.
Trillium nivale Riddell. Snow Trillium. Rare: Liberty. Shaded, moist top of low cliff of limestone along Anderson's Fork.
Smilax herbacea L. Carrion-flower. Frequent in moist woods. Of three collections, one is of var. *herbacea*, while two are of var. *lasioneuron* (Hook.) A. DC.
Smilax ecirrhata (Engelm.) Wats. Collected near New Antioch in 1894 (JSV).
Smilax glauca Walt. var. *glauca*. Glaucous Greenbrier. Scarce: 2. Vernon, Jefferson, Poorly-drained, pin oak woods in ITP.
Smilax hispida Muhl. Bristly Greenbrier. Common in various kinds of woods.

Dioscoreaceae

Dioscorea villosa L. Wild Yam. Infrequent in moist woods.

Amaryllidaceae

Hypoxis hirsuta (L.) Cov. Yellow-eyed-grass. Scarce: 3. Adams, Liberty. Open or thinly-wooded slopes in thin soil over limestone.

Iridaceae

Sisyrinchium graminoides Bickn. (*S. angustifolium* Mill., of G. M.). Blue-eyed-grass. Frequent in moist places in woods and in open.

Orchidaceae

Orchis spectabilis L. Showy Orchis. Infrequent: 4. Green, Chester, Adams. Moist, rich woods and on flood plains. Only a few plants remain.

Habenaria peramoena Gray. Fringeless Purple Orchid. Scarce: 3. Vernon, Jefferson, Clark. Clearings and open pin oak woods on poorly-drained flats of ITP.

Spiranthes cernua (L.) Richard. Ladies'-tresses. Scarce: 2. Vernon, Jefferson. Poorly-drained clearings and woods in ITP.

Liparis liliifolia (L.) Richard. Lily-leaved Twayblade. Rare: Vernon. Moist, well-drained woods.

Aplectrum hyemale (Muhl.) Torr. Putty-root. Rare: Vernon. Moist hillside. (Mr. and Mrs. Arthur Harper and H. H. Vannorsdall.)

Dicotyledoneae

Saururaceae

Saururus cernuus L. Lizard's-tail. Infrequent in wet places and along larger streams.

Salicaceae

Populus grandidentata Michx. Large-toothed Aspen. Rare: Vernon. Forming pure stand over small area of moist woods.

Populus tremuloides Michx. Quaking Aspen. Scarce: 2. Jefferson. Poorly-drained places in ITP.

Populus deltoides Marsh. Cottonwood. Infrequent, mainly in poorly-drained woods of ITP.

Salix caroliniana Michx. Carolina Willow. Rare: Liberty. Along Anderson's Fork.

Salix nigra Marsh. Black Willow. Abundant along streams and in other wet places. This and *S. interior* are the most common willows.

**Salix fragilis* L. Crack Willow. Collected in Liberty Twp. along stream. Undoubtedly elsewhere. Hybrids of this species with *S. alba* L. were collected twice (Washington, Union). In one collection characters of *S. alba* predominate; in the other the reverse is true. Hybrids probably are not uncommon. Although typical *S. alba* has not been collected, it is expected to occur in the county.

Salix interior Rowlee. Sandbar Willow. Common along streams.

Salix rigida Muhl. var. *angustata* (Pursh) Fern. Heart-leaved Willow. Liberty. Along Anderson's Fork. Plants were seen along streams at four other generally-distributed localities, but it is not known whether these are typical variety or var. *angustata*.

Salix discolor Muhl. var. *latifolia* Andersson. Pussy Willow. Rare: Richland. Along a railroad.

Salix humilis Marsh. Upland Willow. Jefferson. Wet place. Expected elsewhere in ITP.

Salix tristis Ait. Dwarf Upland Willow. Collected by Braun in pin oak woods, Westboro, 8–20–23 (specimen determined by C. R. Ball, as are those of present writer).

Juglandaceae

Juglans cinerea L. Butternut. Infrequent in bottomlands.

Juglans nigra L. Black Walnut. Abundant in woods.

Carya cordiformis (Wang.) K. Koch. Bitternut Hickory. Common in woods.

Carya laciniosa (Michx. f.) Loud. Big Shellbark Hickory. Union. In a woodlot.

Carya tomentosa (Poir.) Nutt. Mockernut. Scarce: 2. Chester, Jefferson. In woods.

Carya ovata (Mill.) K. Koch. Shagbark Hickory. Abundant in woods.

Carya ovalis (Wang.) Sarg. Pignut Hickory. Union, Chester, and Wilson. In woods. All specimens with at least one character of *C. glabra*.

Carya glabra (Mill.) Sweet. Pignut Hickory. Union. In a woodlot. This collection has buds like *C. ovalis*.

Corylaceae

Corylus americana Walt. Hazelnut. Frequent in poorly-drained woods, especially in ITP.
Ostrya virginiana (Mill.) K. Koch. Hop Hornbeam, Ironwood. Abundant in various types of woods.
Carpinus caroliniana Walt. Hornbeam, Blue Beech. Abundant in various types of woods.

Fagaceae

Fagus grandifolia Ehrh. Beech. Abundant, but mainly in the western half and southern part of county. Collections are of var. caroliniana (Loud.) Fern. and Rehder.
Quercus alba L. White Oak. Abundant in moist or dry woods.
Quercus stellata Wang. Post Oak. Rare: Wilson. In poorly-drained, oak-hickory woods.
Quercus macrocarpa Michx. Bur Oak. Frequent in moist or dry woods. Usually, only one or a few individuals present at a locality.
Quercus bicolor Willd. Swamp White Oak. Frequent in poorly-drained woods of the ITP, but only occasional elsewhere. One collection suggests introgression from *Q. macrocarpa*.
[*Quercus Prinus* L.] Chestnut Oak. Reported in Transeau and Williams (1929).
Quercus prinoides Willd. var. *acuminata* (Michx.) Gleason (*Q. Muehlenbergii* Engelm.). Chestnut Oak. Common on dry hillsides, usually along larger streams.
Quercus imbricaria Michx. Shingle Oak. Common in woods.
Quercus marilandica Muenchh. Blackjack Oak. Rare: Vernon. Crest of wooded ridge.
Quercus velutina Lam. Black Oak. Collected in two woodlands in Wilson Twp. in poorly-drained soils.
Quercus borealis Michx. f. var. *maxima* (Marsh.) Ashe. Red Oak. Common, usually on slopes, ravines, or uneven topography in rather well-drained sites.
Quercus palustris Muenchh. Pin Oak. Abundant in ITP where it is often a dominant species. Infrequent elsewhere.
Quercus Shumardii Buckley.
Var. *Shumardii*. Shumard Oak. Collected in upland woodlots in Chester and Union Twps.
Var. *Schneckii* (Britt.) Sarg. Schneck Oak. Collected in upland woodlot in Chester Twp., where it grew with var. *Shumardii*. Another specimen from Union Twp. was intermediate between these two varieties.
Note: Hybrid— x *Quercus Leana* Nutt. (*Q. imbricaria* x *Q. velutina*). Lea's Oak. This hybrid was collected in "Clinton Co." from "a little tree four inches in diameter" in 1906 by Stanley B. Stowe (OSU herb.).

Ulmaceae

Ulmus americana L. American or White Elm. Abundant in moist woods.
Ulmus rubra Muhl. Slippery Elm. Common in poorly-drained woods in ITP; frequent along streams elsewhere.
Celtis occidentalis L. Hackberry. Common in lowland woods.

Moraceae

Maclura pomifera (Raf.) Schneid. Osage-Orange. Common as scattered trees in woods; planted formerly as "living fences".
Morus rubra L. Red Mulberry. Frequent in woods.
Humulus Lupulus L. Hops. Wilson—in fence-row.
* *Humulus japonicus* Sieb. & Zucc. Hops. Vernon—in bottomland.

Urticaceae

Urtica dioica L. var. *procera* Wedd. Tall Nettle. Infrequent in moist soil.
Laportea canadensis (L.) Gaud. Wood Nettle. Common in moist woods.
Boehmeria cylindrica (L.) Sw. False Nettle. Infrequent in moist soil.
Pilea pumila (L.) Gray. Clearweed. Common in moist woods.
Parietaria pennsylvanica Muhl. Pellitory. Abundant in open woods, gardens, and waste places.

Aristolochiaceae

Asarum canadense L. var. *canadense*. Wild Ginger. Scarce to infrequent in moist, rich woods, usually on ravine slopes.
Aristolochia Serpentaria L. Virginia Snakeroot. Scarce: 3. Richland, Wilson, Chester. In level, upland woods of various types.

Polygonaceae

* *Rumex Acetosella* L. Sheep Sorrel. Abundant weed in fields.
Rumex verticillatus L. Swamp Dock. Rare: Liberty. Wet border of stream.
* *Rumex crispus* L. Curly Dock. Abundant weed in waste places.
Rumex altissimus Wood. Pale Dock. Rare: Liberty. Wet border of stream.

**Rumex obtusifolius* L. Bitter Dock. Abundant weed in waste places.
Polygonum erectum L. Liberty—along roadside.
**Polygonum aviculare* L. Knotweed. Abundant weed in waste places.
Polygonum coccineum Muhl. Rare: Liberty. Wet border of stream.
Polygonum lapathifolium L. Rare: Washington. Mud flat on north shore of Lake Cowan. This collection represents var. *nodosum* (Raf.) Weinm. of B. & B.
Polygonum pennsylvanicum L. var. *laevigatum* Fern. Smartweed. Common in moist places.
Polygonum punctatum Ell. Smartweed. Abundant in moist places.
**Polygonum Persicaria* L. Lady's Thumb. Frequent in moist places.
Polygonum hydropiperoides Michx. Mild Water Pepper. Scarce: 2. Liberty, Jefferson. Swampy lowland along large streams. Typical variety and form were collected.
Polygonum sagittatum L. Arrow-leaved Tearthumb. Rare: Vernon. Swamp in ITP.
Polygonum arifolium L. Halberd-leaved Tearthumb. Collected in 1936 by Roads.
Polygonum virginianum L. (*Tovara virginiana* (L.) Raf.). Jumpseed. Common in moist woods.
Polygonum scandens L. Climbing False Buckwheat. Frequent along roadsides and in waste places.

Chenopodiaceae

**Chenopodium ambrosioides* L. Mexican Tea. Frequent weed in waste places.
**Chenopodium album* L. Lamb's Quarters. Common weed in waste places.

Amaranthaceae

Amaranthus graecizans L. (*A. blitoides* S. Wats.).. Vernon. In sandy soil along stream.
Amaranthus albus L. (*A. graecizans*, of G. M., 7th ed., and B. & B., 2nd ed.). Union. Along a railroad.
**Amaranthus hybridus* L. Pigweed. Abundant weed in corn fields, gardens, and waste places.
Acnida tuberculata Moq. (*A. altissima* Riddell, of B. & B.). Rare: Wilson. In moist soil along Anderson's Fork in land probably originally prairie or marsh.
Note: A specimen obtained by J. S. Vandervort (O.S.U. herb.) in 1894 near New Antioch has been determined by J. D. Sauer as a sterile hybrid, probably of *Acnida tuberculata* x *Amaranthus hybridus*.

Nyctaginaceae

Oxybaphus nyctagineus (Michx.) Sw. Umbrella-wort. Scarce: near New Vienna (KMR); Union—south of Wilmington; along railroads.

Phytolaccaceae

Phytolacca americana L. Pokeweed. Common in open woods and waste places.

Aizoaceae

**Mollugo verticillata* L. Carpet-weed. Common in corn fields and waste places.

Portulacaceae

**Portulaca oleracea* L. Purslane. Infrequent to frequent in corn fields, gardens, and waste places.
Claytonia virginica L. Spring Beauty. Abundant in moist woods.

Caryophyllaceae

Paronychia canadensis (L.) Wood. Forked Chickweed. Infrequent in dry woods.
**Stellaria media* (L.) Cyrill. Common Chickweed. Abundant weed in fields and waste places.
Stellaria longifolia Muhl. Infrequent: swampy places and moist woods in ITP.
Cerastium nutans Raf. (*C. longipedunculatum*, of authors). Infrequent in woods.
**Cerastium vulgatum* L. var. *hirsutum* Fries. Mouse-ear Chickweed. Abundant weed in fields and waste places.
**Arenaria serpyllifolia* L. Thyme-leaved Sandwort. Infrequent in sandy places along streams and railroads.
Arenaria lateriflora L. Rare: Vernon. In upland woods under beech and red oak.
**Agrostemma Githago* L. Corn Cockle. Occasional weed in pastures and cultivated fields.
Silene antirrhina L. Sleepy Catchfly. Frequent along railroads.
**Silene noctiflora* L. Night-flowering Catchfly. Rare: Union. Border of cultivated field.
Silene stellata (L.) Ait. f. Starry Campion. Infrequent in dry or moist woods. The two collections are intermediate between var. *stellata* and var. *scabrella* (Nieuw.) Palm. & Stey.
Silene virginica L. Fire Pink. Frequent on dry, wooded hillsides.
**Saponaria officinalis* L. Bouncing Bet. Abundant along railroads and in waste places.
**Dianthus Armeria* L. Deptford Pink. Frequent in fields and open woods.

Nymphaeaceae

Nelumbo lutea (Willd.) Pers. Lotus. Rare: Washington. North shore of Lake Cowan.

Magnoliaceae

Magnolia acuminata L. Cucumber Tree. Scarce: 2. Chester—in a field adjoining a woods. Reported from Union by F. O. Hazard. This species appears to be dying out.
Liriodendron Tulipifera L. Tulip Tree, Tulip Poplar. Frequent in moist woods and wooded ravines.

Anonacaeae

Asimina triloba (L.) Dunal. Papaw. Common in moist woods.

Ranunculaceae

Hydrastis canadensis L. Golden Seal. Scarce: 3. Chester, Vernon, Richland. Moist, rich woods: beech-maple; mixed hardwoods; elm-ash.
Cimicifuga racemosa (L.) Nutt. Black Snakeroot. Rare: Vernon. Wooded ravine.
Actaea alba (L.) Mill. White Baneberry. Frequent in moist, rich woods.
Thalictrum dioicum L. Early Meadow Rue. Infrequent on dry, wooded hillsides.
Thalictrum dasycarpum Fisch. & Ave-Lall. Purple Meadow Rue. Frequent in bottomlands and moist places.
Aquilegia canadensis L. Columbine. Frequent on rocky ledges and dry hillsides.
Delphinium tricorne Michx. Dwarf Larkspur. Common in moist woods.
Isopyrum biternatum (Raf.) T. & G. False Rue Anemone. Rare: Adams. Moist, rich, wooded hillside in valley of Todd's Fork.
Caltha palustris L. Marsh Marigold. Rare: Adams. Seepage area around spring at base of "Bunker Hill". (First found by FOH).
Ranunculus ambigens Wats. (*R. obtusiusculus* Raf.). Spearwort. Rare: Marion. Border of temporary pool in ITP.
Ranunculus abortivus L. Small-flowered Buttercup. Common in various types of moist woodlands.
Ranunculus micranthus Nutt. Scarce: 2. Adams, Vernon. Moist, wooded hillsides.
Ranunculus sceleratus L. Cursed Crowfoot. Scarce: Washington, Vernon. Mud flat on north shore of Lake Cowan; sandbar along lower Cowan's Creek.
Ranunculus recurvatus Poir. Hooked Buttercup. Infrequent in moist woods.
Ranunculus septentrionalis Poir. Swamp Buttercup. Frequent in wet or moist places, usually in woods. Separation of this species from *R. hispidus* was made on the basis of the stipule character mentioned by Benson (1948).
Ranunculus hispidus Michx. Bristly Buttercup. Collected by Braun in wet place near Midland in ITP. The specimen is probably var. *hispidus*.
Anemone virginiana L. Thimbleweed. Frequent in dry woods.
Anemone canadensis L. Canada Anemone. Scarce: 2. Liberty, Richland. Moist or wet ditches along roadside and railroad.
[*Anemone quinquefolia* L. var. *interior* Fern.] Wood Anemone. Klock's Crossing, Jefferson Twp. (Braun).
Hepatica acutiloba DC. Hepatica. Frequent in wooded ravines in western half of county.
Anemonella thalictroides (L.) Spach. Rue Anemone. Frequent in well-drained soil in rich woods or dry woods.
Clematis virginiana L. Virgin's Bower. Infrequent in wooded or cleared bottomland.
Clematis Viorna L. Leather Flower. Scarce: 3. Vernon, Liberty, Chester. Dry, wooded hillsides.

Berberidaceae

Podophyllum peltatum L. May Apple. Common in moist woods.
Jeffersonia diphylla (L.) Pers. Twinleaf. Frequent on wooded hillsides; not seen in eastern part of county.
Caulophyllum thalictroides (L.) Michx. Blue Cohosh. Frequent in moist, rich woods.

Menispermaceae

Menispermum canadense L. Moonseed. Common in thickets and woods.

Lauraceae

Sassafras albidum (Nutt.) Nees. Sassafras. Common in woods.
Lindera Benzoin (L.) Blume. Spicebush. Common in wet places in woods.

Papaveraceae

Sanguinaria canadensis L. Bloodroot. Abundant in moist woods.
**Papaver Rhoeas* L. Field Poppy. Collected by KMR in 1937 along a roadside.

Fumariaceae

Dicentra Cucullaria (L.) Bernh. Dutchman's Breeches. Frequent in moist, rich woods and in bottomlands.
Dicentra canadensis (Goldie) Walp. Squirrel-corn. Scarce: 2. "Cowan's Creek" (RR); Washington—north of Lake Cowan in moist, rich woods.
Corydalis flavula (Raf.) DC. Pale Corydalis. Frequent in moist woods.

Cruciferae

**Brassica Kaber* (DC.) L. C. Wheeler. Charlock. Union—weed in garden.
**Brassica nigra* (L.) Koch. Black Mustard. Occasional on dumps and in waste places.
**Erucastrum gallicum* (Willd.) O. E. Schulz. Rare: Liberty. Gravel bar along Anderson's Fork.
**Conringia orientalis* (L.) Andrz. Hare's-ear Mustard. Rare: along railroad near New Vienna (KMR).
**Lepidium campestre* (L.) R. Br. Field Peppergrass. Frequent in fields and waste places.
Lepidium virginicum L. Peppergrass. Frequent in waste places and fields.
**Lepidium densiflorum* Schrader. Rare: Adams. Roadside.
**Thlaspi arvense* L. Field Pennycress. Rare: Green. Snow Hill golf course.
**Thlaspi perfoliatum* L. Scarce: 3. Vernon, Jefferson. In cinders along railroads.
**Capsella Bursa-pastoris* (L.) Medic. Shepherd's Purse. Abundant weed in waste places.
**Alyssum Alyssoides* L. Rare: along railroad in New Vienna (KMR).
**Draba verna* L. Whitlow-grass. Frequent in fields, along railroads, and in waste places. Usually very abundant where found.
Cardamine bulbosa (Schreb.) BSP. Bulbous Bitter-cress. Common in wet places.
Cardamine Douglassii (Torr.) Britt. Purple Bitter-cress. Abundant in moist or dry woods of various types.
Cardamine pensylvanica Muhl. Infrequent in wet places.
Dentaria laciniata Muhl. Cut-leaved Toothwort. Abundant in moist woods of various types.
Dentaria heterophylla Nutt. Rare: Vernon. Moist, rich, wooded ravine, under beech and other hardwoods.
Arabis hirsuta (L.) Scop. var. *adpressipilis* (Hopkins) Rollins. Rare: Liberty. On limestone cliffs.
Arabis canadensis L. Sickle Pod. Scarce: Liberty, Vernon. Moist or dry open woods.
Arabis laevigata (Muhl.) Poir. Smooth Rockcress. Frequent in moist woods, often around rocks.
Arabis Shortii (Fern.) Gleason. (*A. dentata* (Torr.) T. & G.). Rare: Chester. Wooded hillside along Caesar's Creek.
* *Nasturtium officinale* R. Br. Water Cress. Infrequent in wet places.
**Rorippa sylvestris* (L.) Besser. Creeping Yellow-cress. Locally common in Wilson and Liberty Twps. in pastures and wet places in valley of Anderson's Fork.
Rorippa islandica (Oeder) Borbas var. *Fernaldiana* Butters & Abbe (var. *microcarpa* (Regel) Fern.). Infrequent in ditches and wet places.
**Barbarea vulgaris* R. Br. Yellow Mustard. Abundant in fields and waste places.
**Barbarea verna* (Mill.) Asch. Early Winter Cress. Scarce: 3. Vernon, Jefferson. Along railroads.
Iodanthus pinnatifidus (Michx.) Steud. Purple Rocket. Frequent in bottomland woods.
**Erysimum cheiranthoides* L. Rare: along railroad near New Vienna (KMR).
**Alliaria officinalis* Andrz. Garlic Mustard. Locally abundant in valley of Todd's Fork from near Wilmington to Clarksville; also at Sugar Grove Cemetery, Wilmington.
**Sisymbrium officinale* (L.) Scop. Hedge Mustard. Frequent in barnyards and waste places.
**Sisymbrium altissimum* L. Tumble Mustard. Scarce: 2. Richland, Adams. Along railroad and roadside.
**Arabidopsis Thaliana* (L.) Heynh. Mouse-ear Cress. Scarce: 2. Vernon—in field· Wilmington (DLJ).
**Camelina microcarpa* Andrz. Scarce: 2. Union; near New Vienna (KMR). Along railroads.
Descurainia pinnata (Walt.) Britt. var. *brachycarpa* (Richardson) Fern. Scarce: 2. Green; Adams. Roadside; along railroad.

Capparidaceae

Polanisia graveolens Raf. Clammyweed. Infrequent in cinders along railroads.

Crassulaceae

Penthorum sedoides L. Ditch Stonecrop. Frequent along streams and in other wet places.
Sedum ternatum Michx. Stonecrop. Infrequent in moist woods.

Saxifragaceae

Heuchera americana L. var. *brevipetala* R. B. & L. Alum-root. Frequent on rocky hillsides and in woods.
Hydrangea arborescens L. Wild Hydrangea. Frequent at base of wooded hillsides in northwestern half of county.
Ribes Cynosbati L. Wild Gooseberry. Frequent in moist woods.
Ribes americanum Mill. Wild Black Currant. Rare: Liberty. Moist bank of stream.

Hamamelidaceae

Liquidambar Styraciflua L. Sweet Gum. Rare: Jefferson. In poorly-drained woods in ITP with pin oak and other hardwoods. Only three young trees present at this locality.

Platanaceae

Platanus occidentalis L. Sycamore. Abundant along streams and on hillsides.

Rosaceae

Physocarpus opulifolius (L.) Maxim var. *opulifolius*. Ninebark. Rare: Richland. In elm-ash-red maple-silver maple forest.
Spiraea alba DuRoi. Meadow-sweet. Frequent in swampy clearings and open woods of the ITP. Also, near New Antioch (JSV).
Spiraea tomentosa L. Hardhack. Scarce in swampy clearings and open woods of the ITP.
Gillenia stipulata (Muhl.) Trel. Indian Physic. Rare: near Wilmington in 1876 by J. F. James.
Fragaria virginiana Duchesne. Wild Strawberry. Frequent in waste places.
Potentilla simplex Michx. Common Cinquefoil. Infrequent in fields.
**Potentilla norvegica* L. (*P. monspeliensis* L.). Norway Cinquefoil. Infrequent in waste places.
**Potentilla recta* L. Upright Cinquefoil. Frequent in waste places.
Geum vernum (Raf.) T. & G. Spring Avens. Common in moist woods.
Geum canadense Jacq. White Avens. Common in woods.
Geum virginianum L. (*G. flavum* (Porter) Bickn.). Rare: Chester. Moist woods.
Geum laciniatum Murr. Infrequent in north and east in wet places along streams. Two collections are of var. *trichocarpum* Fern., one of var. *laciniatum*. At one locality both varieties were present.
Rubus hispidus L. Swamp Dewberry. Scarce: Jefferson. Swampy clearings in ITP.
Rubus allegheniensis Porter (sensu B. & B.). Common Blackberry. Common in fields and thickets.
Rubus occidentalis L. Black Raspberry. Frequent in woods and thickets.
Agrimonia gryposepala Wallr. Chester—wooded hillside.
Agrimonia rostellata Wallr. Woodland Agrimony. Vernon—on dry hillside under oaks.
Agrimonia parviflora Ait. Small-flowered Agrimony. Frequent in swampy clearings and woods, especially in flats of ITP.
Agrimonia pubescens Wallr. Frequent in moist woods.
Rosa setigera Michx. Prairie Rose. Union—wooded hillside; Liberty—swampy area.
**Rosa Eglanteria* L. (*R. rubiginosa* L.). Sweetbrier Rose, Rare: Union. In field.
Rosa palustris Marsh. Swamp Rose. Chester, Jefferson. In wet places. Probably, infrequent to frequent.
Rosa carolina L. Pasture Rose. Vernon. On dry hillside.
Prunus serotina Ehrh. Wild Black Cherry. Abundant in woods and thickets.
Prunus virginiana L. Choke Cherry. Rare: Liberty. Top of limestone cliff.
Prunus americana Marsh. Wild Plum. Scarce: 3. Wilson, Marion, Vernon. Roadsides and fence-rows.
Prunus hortulana Bailey. Wild Plum. Rare: Marion. In woods with mixed hardwoods. Identification tentative.
Pyrus coronaria L. Wild Crab Apple. Rare: Jefferson. Border of poorly-drained woodland in ITP.
Pyrus ioensis (Wood) Carruth. Wild Crab Apple. Rare: Wilson. Poorly-drained, level, oak-hickory woods.
Pyrus melanocarpa (Michx.) Willd. Black Chokeberry. Scarce in wet places in ITP.
Crataegus Phaenopyrum (L. f.) Medic. Washington Thorn. Scarce: 2. Chester. In thin woods. It is not known whether this is native or planted.
Crataegus crus-galli L. Cockspur Thorn. Frequent in woods and marginal land.
Crataegus punctata Jacq. Dotted Hawthorn. Frequent along streams and on wooded hillsides. One collection represents var. *aurea* Ait.
Crataegus macrosperma Ashe. Vernon. Dry, rocky, wooded hillside. Both the typical variety and var. *roanensis* (Ashe) Palmer were obtained at this locality.
Crataegus pennsylvanica Ashe. Chester. In moist woods.
Crataegus mollis (T. & G.) Scheele. Richland. In moist woods.

Crataegus Calpodendron (Ehrh.) Medic. Richland—in moist woods; Jefferson (Braun herb.).
Amelanchier arborea (Michx. f.) Fern. Shadbush. Infrequent: Vernon, Union, Liberty. On wooded slopes and banks along streams. (First found by FOH).

Caesalpiniaceae

Cercis canadensis L. Redbud. Common in woods.
Gleditsia triacanthos L. Honey Locust. Common in woods.
[*Gymnocladus dioica* (L.) K. Koch.] Kentucky Coffee-tree. Reported by Dr. Kelley Hale from ravine at Bunker Hill, Adams Twp.
Cassia hebecarpa Fern. (*C. marylandica* of auth.). Wild Senna. Frequent in moist places.

Fabaceae

Baptisia leucantha T. & G. White False Indigo. Rare: near Cuba at edge of woods in 1937 (KMR).
**Trifolium pratense* L. Red Clover. Frequent escape from cultivation.
**Trifolium repens* L. White Clover. Abundant in lawns and waste places.
**Trifolium hybridum* L. Alsike Clover. Common in waste places and fields.
Trifolium stoloniferum Muhl. Buffalo Clover. Rare: near Wilmington in 1876 (D. L. James).
**Trifolium dubium* Sibth. Little Hop Clover. Rare: Union. In field.
**Melilotus alba* Desr. White Sweet Clover. Common along roadsides and in waste places.
**Melilotus officinalis* (L.) Lam. Yellow Sweet Clover. Common in same habitats as preceding species.
**Medicago lupulina* L. Black Medick. Common in lawns, pastures, and waste places.
**Medicago sativa* L. Alfalfa. Occasional along roadsides and waste places.
Psoralea Onobrychis Nutt. Rare: near New Antioch in 1892 (JSV).
Robinia Pseudo-acacia L. Black Locust. Common in thickets and woodland borders.
Desmodium nudiflorum (L.) DC. Scarce: near New Antioch (JSV); Vernon: dry hillside; moist woods.
Desmodium glutinosum (Muhl.) Wood. Near Antioch in 1892 (JSV). Probably occurs elsewhere.
Desmodium pauciflorum (Nutt.) DC. Wilson (W. C. herb.).
Desmodium rotundifolium DC. Prostrate Tick-trefoil. Rare: Vernon. Dry, wooded ridge.
Desmodium canescens (L.) DC. Chester. Bottomland field.
Desmodium rigidum (Ell.) DC. Rare: Liberty. Dry thicket.
Desmodium paniculatum (L.) DC. Panicled Tick-trefoil. Frequent in woods and waste places.
Desmodium Dillenii Darl. Vernon (WC herb.). Other specimens are immature and identification uncertain. Probably elsewhere in county.
Desmodium cuspidatum (Muhl.) Loud var. *cuspidatum* (*D. bracteosum* (Michx.) DC.). Vernon—wooded bottomland.
Lespedeza procumbens Michx. Trailing Bush Clover. Rare: Vernon. Dry, wooded ridge.
Lespedeza violacea (L.) Pers. Violet Bush Clover. Infrequent in dry woods.
Lespedeza virginica (L.) Britt. Virginia Bush Clover. Rare: Liberty. Dry opening, over limestone.
Lespedeza intermedia (Wats.) Britt. Rare: Vernon. Dry, wooded ridge.
**Lespedeza striata* (Thunb.) H. & A. Japanese Bush Clover. Rare: near New Vienna in 1938 along railroad (KMR).
**Vicia villosa* Roth. Hairy Vetch. Occasional along roadsides.
Apios americana Medic. Groundnut. Infrequent along streams and in wet places.
Amphicarpa bracteata (L.) Fern. Hog Peanut. Common in woods. Collections are variously intermediate between var. *bracteata* and var. *comosa* (L.) Fern.
Strophostyles helvola (L.) Ell. Scarce: 2. Jefferson. Along railroads in ITP.

Oxalidaceae

Oxalis europaea Jord. var. *europaea*. Yellow Wood Sorrel. Abundant in fields, woods, and waste places. The number of collections of certain forms follows: forma *cymosa* (Small) Wieg. — 1; f. *europaea*—2; f. *villicaulis* Wieg.—2.
Oxalis grandis Small. Great Yellow Wood Sorrel. Scarce: 3. Chester, Vernon. Dry woods.
Oxalis violacea L. Violet Wood Sorrel. Frequent in rich woods. Collections include both typical variety and var. *trichophora* Fassett.

Geraniaceae

Geranium maculatum L. Wild Geranium. Common in woods.
Geranium carolinianum L. var. *confertiflorum* Fern. Scarce in waste places.

Linaceae

Linum striatum Walt. Scarce: 2. Jefferson. Poorly-drained meadows and woods in ITP.

Rutaceae

Zanthoxylum americanum Mill. Prickly Ash. Frequent in moist or dry woods.
Ptelea trifoliata L. Hop Tree. Scarce in woods.

Simarubaceae

**Ailanthus altissima* (Mill.) Swingle. Tree-of-heaven. Occasional in waste places.

Polygalaceae

Polygala sanguinea L. Field Milkwort. Scarce: 3. Jefferson. In poorly-drained fields in ITP.

Euphorbiaceae

Phyllanthus caroliniensis Walt. Scarce: 2. Marion, Jefferson. In fallow fields and swampy clearings in ITP.
Acalypha rhomboidea Raf. Three-seeded Mercury. Frequent in waste places.
Acalypha virginica L. Jefferson. In pasture.
Euphorbia maculata L. (*E. Preslii* Guss.). (cf. Fosberg, 1953). Spotted Spurge. Abundant in cultivated fields, gardens, and waste places.
Euphorbia supina Raf. (*E. maculata* L. of B. & B.). (cf. Fosberg, 1953). Frequent weed in fields, city streets, and waste places.
Euphorbia corollata L. Flowering Spurge. Rare: Vernon. Dry, wooded hillside.
Euphorbia dentata Michx. Scarce weed along railroads.
**Euphorbia Cyparissias* L. Cypress Spurge. Scarce: 2. Green (CPI); Union (HHV). Spreading in cemeteries.

Limnanthaceae

Floerkea proserpinacoides Willd. False Mermaid. Infrequent: 5. Wilson, Richland, Union. In moist woods.

Anacardiaceae

Rhus radicans L. Poison Ivy. Abundant in woods and all kinds of waste places. One woodland collection is var. *vulgaris* (Michx.) DC. forma *Negundo* (Greene) Fern.
Rhus glabra L. Snooth Sumac. Frequent in waste land.

Aquifoliaceae

Ilex verticillata (L.) Gray. Winterberry. Infrequent: Jefferson, Marion. Roadsides and open woods in flats of ITP. Collections are of var. *padifolia* (Willd.) T. & G.

Celastraceae

Celastrus scandens L. Bittersweet. Common in woods, thickets, and along roadsides.
Euonymus atropurpureus Jacq. Wahoo. Frequent in woods, often bottomland.
Euonymus obovatus Nutt. Running Strawberry-bush. Infrequent: 5. Richland, Jefferson, Chester, Vernon, Green. In moist woods.

Staphyleaceae

Staphylea trifolia L. Bladdernut. Scarce in woods.

Aceraceae

Acer saccharum Marsh. (cf. Desmarais, 1952).
Subsp. *saccharum*. Sugar Maple. Abundant in woods; often a dominant species.
Subsp. *nigrum* (Michx. f.) Desmarais. Black Maple. Infrequent in moist woods and bottomlands; in more mesic habitats than Sugar Maple. Many trees are intermediate and suggest hybridization between the subspecies.
Acer rubrum L. var. *rubrum*. Red Maple. Frequent in poorly-drained woods.
Acer saccharinum L. Silver Maple. Infrequent along streams and in poorly-drained woods.
Acer Negundo L. Box-Elder. Abundant in bottomlands and in poorly-drained woods. The single collection is of var. *Negundo*.

Hippocastanaceae

Aesculus glabra Willd. var. *glabra*. Ohio Buckeye. Frequent in moist woods. Not seen in eastern part of county.

Balsaminaceae

Impatiens biflora Walt. Spotted Touch-me-not, Jewelweed. Common in bottomlands and moist woods.
Impatiens pallida Nutt. Pale Touch-me-not, Pale Jewelweed. Infrequent in bottomlands and moist woods.

Vitaceae

Vitis Labrusca L. Fox Grape. Infrequent in ITP in moist woods and along roadsides.
Vitis aestivalis Michx. Summer Grape. Infrequent: dry, wooded hillsides; moist, poorly-drained woods.
Vitis vulpina L. (*V. cordifolia* Michx.). Frost Grape. Frequent in woods and thickets, especially along streams. Intermediates with *V. riparia* are more abundant than plants of *V. vulpina*, but most intermediates are nearer *V. vulpina* in morphology than to *V. riparia*.
Vitis riparia Michx. Frost Grape. Collected in Liberty Twp. in swampy land along Anderson's Fork. See preceding species.
Parthenocissus quinquefolia (L.) Planch. Virginia Creeper. Abundant in woods.

Tiliaceae

Tilia americana L. Basswood. Common in moist woods, but rarely present in much abundance.

Malvaceae

**Malva neglecta* Wallr. Common Mallow. Common weed in waste places.
**Sida spinosa* L. Common weed in waste places.
**Abutilon Theophrasti* Medic. Buttonweed, Velvet Leaf. Abundant weed in cultivated land.
**Hibiscus Trionum* L. Flower-of-an-hour. Common weed in gardens and cultivated land.

Hypericaceae

Hypericum prolificum L. Shrubby St. John's-wort. Infrequent in moist or wet places.
Hypericum sphaerocarpum Michx. Scarce: 2. Liberty, Wilson. Stream bank; roadside. In land which was formerly prairie or marsh.
**Hypericum perforatum* L. Common St. John's-wort. Common in fields and waste places.
Hypericum punctatum Lam. Spotted St. John's-wort. Common in fields and waste places.
Hypericum mutilum L. Scarce: Jefferson. Moist fields. Perhaps not uncommon in ITP.
Hypericum Drummondii (Grev. & Hook.) T. & G. Scarce: 2. Jefferson. Moist fields in ITP.

Violaceae

Viola papilionacea Pursh. Common Blue Violet. Abundant in woods and waste places.
Viola sororia Willd. Hairy Blue Violet. Common in woods.
Viola cucullata Ait. Marsh Blue Violet. Infrequent in wet places in ITP.
Viola triloba Schwein. Scarce: 3. Chester, Union. Moist woods.
Viola pallens (Banks) Brain. Rare: near Westboro in "wet moss, pin oak swamp forest" in 1930 (Braun).
[*Viola lanceolata* L.] Lance-leaved Violet. Meadow at Klock's Crossing, Jefferson Twp. (reported by Braun).
Viola eriocarpa Schw. (*V. pensylvanica* Michx.). Smooth Yellow Violet. Common in moist, rich woods. Plants nearest this species but with certain characters of *V. pubescens* Ait. are of frequent occurrence.
Viola striata Ait. Cream Violet. Frequent in bottomlands.
**Viola Rafinesquii* Greene. Field Pansy. Rare: vacant lot in Wilmington in 1938 (RR).
Note: Hybrid—[*V. hirsutula* Brain. x *V. papilionacea* Pursh] Wet meadows, Blanchester, 4–22–1913. (Braun herb.; det. by Ezra Brainerd).
Cubelium concolor (Forst.) Raf. Green Violet. Rare: Vernon. Wooded hillside.

Thymeleaceae

Dirca palustris L. Leatherwood. Infrequent in moist or dry woods.

Lythraceae

Cuphea petiolata (L.) Koehne. Blue Waxweed. Frequent in open woods and fields.
Lythrum alatum Pursh. Winged Loosestrife. Scarce in eastern part of county in moist places along railroads.

Melastomaceae

[*Rhexia virginica* L.] Meadow Beauty. Meadow, Klock's Crossing, Jefferson Twp. (Braun).

Onagraceae

Ludwigia palustris (L.) Ell. Water Purslane. Frequent in wet places.
Ludwigia alternifolia L. Seedbox. Infrequent in wet places in ITP.
Epilobium coloratum Biehler. Willow-herb. Frequent in wet places.
Oenothera biennis L. Evening-Primrose. Common in waste places.

Oenothera parviflora L. Evening-Primrose. Rare: Jefferson. Moist field in ITP.
Oenothera laciniata Hill var. *laciniata*. Rare: near New Vienna in 1935, along railroad (KMR).
Oenothera fruticosa L. Sundrops. Rare: near Midland in 1923 (ELB).
Gaura biennis L. Frequent in moist, open places, usually along streams.
Circaea quadrisulcata (Maxim.) Franch. & Sav. var. *canadensis* (L.) Hara. (*C. latifolia* Hill). Enchanter's Nightshade. Frequent in moist, rich woods.

Araliaceae

Aralia racemosa L. Spikenard. Infrequent in moist, rich woods.
Panax quinquefolium L. Ginseng. Scarce: 3. Chester, Wilson. In moist, rich woods. Almost exterminated.

Umbelliferae

Sanicula gregaria Bickn. Sanicle. Infrequent in woods.
Sanicula canadensis L. Sanicle. Frequent in woods.
Sanicula trifoliata Bickn. Sanicle. Scarce in woods.
Erigenia bulbosa (Michx.) Nutt. Harbinger-of-Spring. Frequent in moist, rich, well-drained woods.
Cryptotaenia canadensis (L.) DC. Honewort. Frequent in woods.
**Torilis japonica* (Houtt.) DC. (*T. Anthriscus* (L.) Gmel.). Rare: near New Vienna along railroad in 1939 (KMR).
Osmorrhiza Claytoni (Michx.) Clarke. Sweet Cicely. Scarce to infrequent in moist woods.
Osmorrhiza longistylis (Torr.) DC. Long-styled Sweet Cicely. Frequent in moist woods.
**Daucus Carota* L. Wild Carrot, Queen Anne's Lace. Abundant along roadsides, in fields, and waste places.
Chaerophyllum procumbens (L.) Crantz. Chervil. Frequent in moist places.
Taenidia integerrima (L.) Drude. Infrequent in western and northern parts, on dry, wooded hillsides.
Zizia aurea (L.) Koch. Golden Alexanders. Near Antioch (JSV).
Zizia aptera (Gray) Fern. Vernon. On wooded hillside.
**Conium maculatum* L. Poison Hemlock. Scarce: 2. Union, Vernon. Roadside; railroad.
Cicuta maculata L. Water Hemlock. Frequent in swampy places, mainly in ITP.
Thaspium trifoliatum (L.) Gray. Meadow Parsnip. Chester, Vernon. On wooded slopes.
Thaspium barbinode (Michx.) Nutt. Hairy-jointed Meadow Parsnip. Union. Border of woods.
Oxypolis rigidior (L.) Raf. Cowbane. Scarce in wet places in woods and in open in ITP.
**Pastinaca sativa* L. Wild Parsnip. Abundant along roadsides, in fields, and waste places.

Cornaceae

Cornus florida L. Flowering Dogwood. Common in woods.
Cornus Purpusi Koehne. Collected in Liberty Twp. along Anderson's Fork. Six other generally-distributed collections are variously intermediate between this species and *C. Amomum* Mill.
Cornus Drummondii C. A. Mey. Rough-leaved Dogwood. Rare: Vernon. Bottomland woods.
Cornus racemosa Lam. Gray Dogwood. Frequent in ITP in wet places; not seen elsewhere.
Nyssa sylvatica Marsh. var. *caroliniana* (*Poir.*) Fern. Sour Gum, Black Gum, Tupelo. Frequent in moist woods; mainly in ITP.

Ericaceae

Monotropa uniflora L. Indian Pipe. Occasional in moist, rich woods.
[*Vaccineum stamineum* L.] Deerberry. Woods near Westboro, Jefferson Twp. (Braun).
Vaccineum vacillans Torr. Low Blueberry. Rare: pin oak forest near Westboro in 1924 (Braun). Determined in 1939 by W. H. Camp as *V. Torreyanum* Camp.

Primulaceae

Samolus floribundus HBK. Water Pimpernel. Frequent in wet places.
**Lysimachia Nummularia* L. Moneywort. Frequent in fields and along streams.
Steironema ciliatum (L.) Raf. Fringed Loosestrife. Frequent in wet places.
Steironema lanceolatum (Walt.) Gray. Frequent in moist fields and wet places. Two collections intergrade with *S. hybridum* (Michx.) Raf.

Oleaceae

Fraxinus americana L. White Ash. Abundant in moist woods.
Fraxinus biltmoreana Beadle. Biltmore Ash. Union—in field on upland; Vernon—bottomland woods.
Fraxinus pennsylvanica Marsh. Red Ash. Liberty—swampy area along Anderson's Fork. Glabrous form: Union—bottomland pasture.
Fraxinus quadrangulata Michx. Blue Ash. Frequent on wooded slopes.
Fraxinus nigra Marsh. Black Ash. Rare: Chester. Moist, level woods.

Gentianaceae

Sabatia angularis (L.) Pursh. Sabatia. Scarce: 3. Green, Vernon, Jefferson. Moist places and abandoned fields.

[*Gentiana Saponaria* L.] Soapwort Genitan. Wet upland meadows near Midland, 9–14 1921 (Braun herb.).

Swertia caroliniensis (Walt.) Kuntze. American Columbo. Rare: Vernon. Dry wooded slope.

Apocynaceae

**Vinca minor* L. Periwinkle. Scarce in waste places.

Apocynum cannabinum L. Indian Hemp. Frequent in open woods and fields.

Asclepiadaceae

Asclepias tuberosa L. Butterfly Weed. Scarce: Chester, Green. Abandoned fields and roadsides. Collections are intermediate between subsp. *tuberosa* and subsp. *interior* Woodson.

Asclepias incarnata L. var. *incarnata*. Swamp Milkweed. Common along streams and in wet places.

Asclepias syriaca L. Common Milkweed. Abundant in fields and waste places.

Asclepias quadrifolia Jacq. Four-leaved Milkweed. Scarce: 2. Vernon. Moist woods.

Ampelamus albidus (Nutt.) Britt. Bluevine. Frequent: climbing on fences; garden weed in Wilmington.

Convolvulaceae

**Ipomoea purpurea* (L.) Roth. Common Morning Glory. Occasional as weed in gardens and cultivated fields.

**Ipomoea hederacea* Jacq. Ivy-leaved Morning Glory. Frequent in fields and waste places.

Ipomoea pandurata (L.) G. F. W. Mey. Wild Potato Vine. Rare: Vernon. Dry hillside.

Ipomoea lacunosa L. Rare: near New Vienna along railroad in 1937 (KMR).

**Convolvulus arvensis* L. Field Bindweed. Richland. In cinders along railroad.

Convolvulus sepium L. Hedge Bindweed. Common in fields and waste places. Collections include both var. *sepium* and var. *communis* Tryon.

Cuscuta Gronovii Willd. Common Dodder. Frequent in wet places, usually along streams.

Polemoniaceae

Phlox divaricata L. var. *divaricata*. Wild Blue Phlox. Common in moist woods. Plants with white flowers seen at two localities.

Phlox paniculata L. Garden Phlox. Frequent in wooded bottomlands.

Phlox maculata L. Spotted Phlox. Scarce: Jefferson, Vernon. Swampy places in ITP.

Polemonium reptans L. Jacob's Ladder, Greek Valerian. Common in moist woods.

Hydrophyllaceae

Phacelia Purshii Buckley. Miami Mist. Infrequent in bottomlands, on wooded hillsides, and along roadsides; seen only in western part.

Hydrophyllum macrophyllum Nutt. Large-leaved Waterleaf. Abundant in moist woods.

Hydrophyllum virginianum L. Virginia Waterleaf. Rare: Richland. Elm-ash woods.

Hydrophyllum canadense L. Canada Waterleaf. Infrequent in moist, rich woods, usually at bases of hillsides, in western half of county.

Hydrophyllum appendiculatum Michx. Appendaged Waterleaf. Scarce in moist, rich woods.

Boraginaceae

**Echium vulgare* L. Viper's Bugloss, Blueweed. Rare: near New Antioch in 1892 (JSV).

**Lithospermum arvense* L. Corn Gromwell. Infrequent along roadsides and railroads.

Myosotis macrosperma Engelm. (*M. virginica* (L.) BSP. var *macrosperma* (Engelm.) Fern.) Infrequent in moist woods.

**Cynoglossum officinale* L. Hound's Tongue. Scarce: Liberty, Vernon. Waste places.

Cynoglossum virginianum L. Wild Comfrey. Scarce: 2. Marion, Vernon. Dry woods.

Hackelia virginiana (L.) Johnston. (*Lappula virginiana* (L.) Greene). Stickseed. Frequent in woods.

Mertensia virginica (L.) Pers. Virginia Bluebells. Rare: Union. Moist, rich woods.

Verbenaceae

Verbena urticifolia L. White Vervain. Common in open woods and along streams. Both var. *urticifolia* and var. *leiocarpa* Perry & Fern. have been collected.

Verbena hastata L. Blue Vervain. Common in open woods and along streams.

Phyla lanceolata (Michx.) Greene. Fog-fruit. Frequent in bottomland along streams.

Labiatae

Teucrium canadense L. American Germander. Frequent in open woods and fields. Two collections are of var. *virginicum* (L.) Eaton; one collection is intermediate between this and var. *occidentale* (Gray) McClintock & Epling.
Isanthus brachiatus (L.) BSP. False Pennyroyal. Infrequent in fields, open woods, and along railroads.
Scutellaria ovata Hill var. *versicolor* (Nutt.) Fern. Skullcap. Rare: Chester; Moist, rich woods along stream.
Scutellaria incana Biehler var. *incana*. Skullcap. Infrequent in dry woods and fields.
Scutellaria lateriflora L. Skullcap. Frequent along streams.
Scutellaria parvula Michx. Scarce: 2. Union. Along railroad; along stream.
**Marrubium vulgare* L. Horehound. Common weed in fields and waste places.
Agastache nepetoides (L.) Ktze. Giant Hyssop. Infrequent in woods.
**Nepeta Cataria* L. Catnip. Frequent to common in fields and waste places.
**Glecoma hederacea* L. Ground Ivy, Gill-over-the-ground.
Var. *hederacea*. Rare: Wayne. In hickory woods.
Var. *parviflora* (Benth.) Druce. Abundant weed in lawns, gardens, fields, and waste places.
Prunella vulgaris L. Self-heal. Common weed in waste places. Collections are of var. *lanceolata* (Bart.) Fern.
Dracocephalum virginianum L. Dragon-head. Rare: near Midland in wet ditch along roadside.
Dracocephalum formosius (Lunell) Rydb. Dragon-head. Scarce: 2. Liberty—swampy bank of stream; New Antioch (JSV).
**Lamium amplexicaule* L. Henbit. Infrequent weed in waste places.
**Lamium purpureum* L. Purple Dead Nettle. Common weed in waste places; sometimes very abundant where found. A white-flowered form has been collected.
**Leonurus Cardiaca* L. Motherwort. Common weed in fields and waste places.
Stachys palustris L. var. *palustris*. Hedge Nettle. Rare: Union. Hillside by Todd's Fork.
Stachys tenuifolia Willd. Hedge Nettle. Rare: Chester. On bank of stream.
Stachys hispida Pursh. Hedge Nettle. Scarce: Union, Wilson. Banks of streams.
Stachys Riddellii House. (*S. cordata* Riddell). Hedge Nettle. Scarce: 3. Chester—moist, rich woods; woods near Blanchester (KMR).
Salvia reflexa Hornem. (*S. lanceaefolia*, of G. M., 7th ed.). Rare: Chester. In corn field.
Monarda fistulosa L. Wild Bergamot. Frequent in open woods, fields, and along roadsides.
Monarda clinopodia L. Rare: Union. Moist woods.
Blephilia hirsuta (Pursh) Benth. Wood Mint. Scarce: 3. Chester, Richland, Wilson. Moist, rich woods.
Hedeoma pulegioides (L.) Pers. Pennyroyal. Common in fields and woods.
Pycnanthemum flexuosum (Walt.) BSP. Mountain Mint. Infrequent in ITP in swampy places.
Pycnanthemum virginianum (L.) Durand & Jackson. Mountain Mint. Scarce: 2. Richland—along railroad; New Antioch (JSV).
Lycopus virginicus L. Water Horehound. Frequent in wet places.
Lycopus americanus Muhl. Water Horehound. Frequent in wet places.
Lycopus rubellus Moench. Water Horehound. Rare: near New Antioch, 1892 (JSV).
Mentha arvensis L. var. *villosa* Benth. Field Mint. Frequent in moist places.
**Mentha spicata* L. Spearmint. Common in moist places, usually along streams.
**Mentha rotundifolia* (L.) Huds. Rare: near Farmer's Station in 1936 along a road (KMR).
Collinsonia canadensis L. Stoneroot. Infrequent: 5. Marion, Vernon, Union, Green, Adams. Moist, rich woods.
**Perilla frutescens* (L.) Britt. Rare: near Vienna in 1934 (KMR).

Solanaceae

* *Nicandra physalodes* (L.) Gaertn. Apple-of-Peru. Scarce: 3. Vernon, Chester, near New Antioch (JSV). In corn fields.
Physalis pubescens L. Wayne. In cultivated field.
Physalis heterophylla Nees. Scarce to infrequent in waste land.
Physalis subglabrata Mack. & Bush. Smooth Ground Cherry. Common in fields and waste places.
**Solanum Dulcamara* L. Occasional in waste places.
Solanum americanum Mill. Nightshade. (cf. Stebbins and Paddock, 1949; Fernald, 1950). Infrequent to frequent in open woods and fields. Formerly, known incorrectly as *S. nigrum* L.
Solanum carolinense L. Horse Nettle, Sand Brier. Frequent weed in fields and waste places.
**Datura Stramonium* L. Jimson Weed. Common weed in cultivated fields and waste places.

Scrophulariaceae

Gratiola neglecta Torr. Frequent in ITP in wet places.

Leucospora multifida (Michx.) Nutt. Frequent in wet places by streams.
Mimulus ringens L. Monkey Flower. Frequent in wet places.
Mimulus alatus Ait. Winged Monkey Flower. Frequent to common in wet places.
Lindernia dubia (L.) Pennell.
Var. *dubia*. Scarce: Vernon. Wet places.
Var. *riparia* (Raf.) Fern. Rare: Washington. Shore of Lake Cowan.
**Verbascum Thapsus* L. Mullein. Abundant weed in fields and waste places.
**Verbascum Blattaria* L. Moth Mullein. Common weed in fields and waste places.
Chelone glabra L. Turtlehead. Scarce: Jefferson, Adams. Wet places.
Penstemon Digitalis Nutt. Foxglove Beard-Tongue. Infrequent to frequent on roadsides and in fields. Collection from northeast Wilmington closer to *P. alluviorum* Pennell, but this species probably should be united with *P. Digitalis*.
[*Penstemon calycosus* Small] Cited by Pennell (1935) from Blanchester (Braun). Probably, to be found elsewhere in county.
Penstemon pallidus Small. Rare: Adams. Wooded hillside.
Scrophularia marilandica L. Figwort. Frequent in woods.
Collinsia verna Nutt. Blue-eyed Mary. Rare: Chester. In open woods.
**Linaria vulgaris* Hill. Butter-and-Eggs. Scarce: 2. Richland—along roadside; New Vienna (CPI).
**Chaenorrhinum minus* (L.) Lange. Infrequent along railroads.
Veronicastrum virginicum (L.) Farw. Culver's Root. Scarce: Wilson—poorly-drained oak-hickory woods; New Antioch (JSV).
**Veronica serpyllifolia* L. Thyme-leaved Speedwell. Infrequent in fields.
Veronica peregrina L. var. *peregrina*. Purslane Speedwell. Infrequent in cultivated fields.
**Veronica arvensis* L. Corn Speedwell. Union. Along stream.
Veronica officinalis L. Common Speedwell. Frequent in fields and woods.
Veronica salina Schur. (*V. comosa* Richter, of G. M.) Rare: Liberty. Muddy bed of stream.
Dasistoma macrophylla (Nutt.) Raf. Mullein Foxglove. Frequent in woods.
Aureolaria flava (L.) Farw. var. *macrantha* Pennell. False Foxglove. Rare: near Westboro in openings of pin oak woods, 1924 (Braun).
Gerardia purpurea L. var. *purpurea*. Purple Gerardia. Scarce in ITP: 2. Jefferson. Moist, fallow field; moist soil along railroad.
Gerardia tenuifolia Vahl var. *tenuifolia*. Slender Gerardia. Scarce: 2. Vernon. Dry, wooded slopes.
Pedicularis canadensis L. Wood Betony, Lousewort. Rare: Jefferson. Moist clearing in pin oak forest.

Bignoniaceae

Campsis radicans (L.) Seem. Trumpet-creeper, Trumpet Vine. Common along roadsides and in woods.

Orobanchaceae

Conopholis americana (L.) Wallr. Squaw-root. Rare: Vernon. In moist, rich woods, under beech and sour gum.
Epifagus virginiana (L.) Bart. Beech-drops. Frequent in woods, under beech.

Acanthaceae

Ruellia strepens L. Smooth Ruellia. Frequent in woods.
Ruellia humilis Nutt. var. *frondosa* Fern. Scarce: Liberty, Richland. Dry, open place; on railroad embankment.
Justicia americana (L.) Vahl. (*Dianthera americana* L.). Water Willow. Abundant on bars and in shallow water in all large streams.

Phrymaceae

Phryma Leptostachya L. Lopseed. Frequent in woods.

Plantaginaceae

Plantago Rugelii Dcne. Rugel's Plantain. Abundant along roadsides, in lawns and fields, and and in all kinds of waste places.
**Plantago lanceolata* L. English Plantain. Abundant in same and similar habitats as preceding species.
Plantago virginica L. Dwarf Plantain. Scarce: 3. Union, Liberty, Vernon. In pastures, fields and waste places.
Plantago aristata Michx. Large-bracted Plantain. Infrequent in eroded fields and waste places, particularly in southern part of county.

Rubiaceae

Houstonia caerulea L. Bluets. Scarce: 3. Vernon, Jefferson. Moist or wet soil in open woods.
Houstonia purpurea L. Large Houstonia. Frequent: 8. Union, Chester, Liberty, Vernon, Washington. Moist or dry woods of various types; crevices of limestone cliff; abandoned field; dry, open slope.
Mitchella repens L. Partridgeberry. Infrequent: 4. Vernon, Jefferson. In pin oak woods and beech woods of ITP.
Cephalanthus occidentalis L. Buttonbush. Infrequent in wet places and along streams.
Diodia teres Walt. var. *teres*. Rare: Jefferson. Along railroad.
Galium circaezans Michx. var. *hypomalacum* Fern. Wild Licorice. Frequent in woods.
Galium pilosum Ait. Hairy Bedstraw. Chester. In abandoned field.
Galium Aparine L. Cleavers. Common in moist woods and waste places.
Galium triflorum Michx. Sweet-scented Bedstraw. Common in moist woods.
**Galium verum* L. Yellow Bedstraw. Rare: Union. In field.
Galium concinnum T. & G. Pretty Bedstraw. Common in dry woods.
Galium obtusum Bigel. Scarce to infrequent in wet places.
Galium tinctorium L. (*G. Claytoni* Michx.). Infrequent in wet places.

Caprifoliaceae

Viburnum acerifolium L. Maple-leaved Viburnum. Scarce in moist woods.
Viburnum Lentago L. Nannyberry. Infrequent in swampy woods.
Viburnum prunifolium L. Black Haw. Frequent in woods.
Viburnum dentatum L. var. *Deamii* (Rehder) Fern. (sensu B. & B.). Infrequent: Jefferson, Clark. Poorly-drained woods of ITP.
Sambucus canadensis L. Elderberry. Common in moist places.
**Lonicera japonica* Thunb. Japanese Honeysuckle. Union. Woods by Sugar Grove Cemetery, Wilmington.
Lonicera prolifera (Kirchn.) Rehder. (*L. Sullivantii* Gray). Grape Honeysuckle. Rare: Richland. Elm-ash woods.
Symphoricarpus orbiculatus Moench. Coralberry. Scarce: Jefferson—along railroad; "Clinton Co." (CGW).
Triosteum perfoliatum L. (sensu lat.). Horse-gentian. Scarce: Wilson, Richland. Present taxonomic treatments of its varieties are inadequate.

Valerianaceae

Valeriana pauciflora Michx. Scarce: 2. Vernon, Adams. In moist, rich, wooded bottomland.
Valerianella radiata (L.) Dufr. Corn Salad.
Var. *radiata*. Common in moist places.
Var. *intermedia* (Dyal) Gleason was collected in 1902 by C. P. Ingold, whose specimen was determined by Sarah C. Dyal.

Dipsacaceae

**Dipsacus sylvestris* Huds. Teasel. Common in open woods, fields, and waste places.

Cucurbitaceae

Echinocystis lobata (Michx.) T. & G. Wild Balsam-apple. Scarce in bottomlands.
Sicyos angulatus L. Bur Cucumber. Scarce in bottomlands.

Campanulaceae

Campanula americana L. Tall Bellflower. Common in woods.
Specularia perfoliata (L.) A. DC. Venus' Looking Glass. Scarce in moist places.

Lobeliaceae

Lobelia Cardinalis L. Cardinal Flower. Infrequent in wet places, mainly in ITP.
Lobelia siphilitica L. Great Lobelia. Common in moist places. Forma *albiflora* (Britt.) House was collected in Union Twp.
Lobelia inflata L. Indian Tobacco. Common in open woods and fields.

Compositae

Helianthus hirsutus Raf. Rare: Clark. Along railroad.
Helianthus decapetalus L. Wild Sunflower. Rare: near Farmer's Station in 1901 (CPI).
Helianthus tuberosus L. Jerusalem Artichoke. Abundant along roadsides and in bottomlands.
Helianthus grosseserratus Martens. Sawtooth Sunflower. Rare: Union. Dry soil along railroad.

Verbesina alternifolia (L.) Britt. (*Actinomeris alternifolia* (L.) DC.). Wing-stem. Common in fields and bottomlands.

Eclipta alba (L.) Hassk. Yerba de Tajo. Infrequent along streams and in wet places. in bottomlands; often with *Helianthus tuberosus*.

Rudbeckia hirta L. (sens. lat.) Black-eyed Susan. Common in fields and waste places. Quite variable.

Rudbeckia fulgida Ait.

Var. *Sullivantii* (Boynton & Beadle) Cron. (incl. *R. speciosa* Wenderoth). Scarce: 2. Union—wet place; near Blanchester (ELB)

Var. *fulgida*. Rare: near Blanchester in fields (ELB).

Rudbeckia triloba L. Brown-eyed Susan. Frequent in open woods and moist places.

Rudbeckia laciniata L.

Var. *laciniata*. Coneflower. Frequent in bottomlands.

*Var. *hortensis* Bailey. Golden-glow. Near New Vienna in 1939 along railroad (KMR).

Bidens cernua L. Nodding Bur Marigold. Frequent in wet places.

Bidens tripartita L. (incl. *B. comosa* (Gray) Wieg.). Chester. Along stream.

Bidens frondosa L. Beggar's Ticks. Frequent in moist places.

Bidens vulgata Greene var. *vulgata*. Beggar's Ticks. Frequent in moist places.

Bidens bipinnata L. Spanish Needles. Common in moist places.

Bidens polylepis Blake. Infrequent in ITP in fields.

**Cosmos bipinnatus* Cav. Cosmos. Near Blanchester in field, 1935 (KMR).

Coreopsis tripteris L. Tall Coreopsis. Infrequent: Jefferson. Moist places in woods and in open in ITP.

**Galinsoga ciliata* (Raf.) Blake. Galinsoga. Common weed in cultivated land.

Polymnia canadensis L. Leafcup. Rare: Vernon. Bottomland woods.

Silphium perfoliatum L. Cup-plant. Frequent in bottomlands along larger streams.

Silphium trifoliatum L. var. *trifoliatum*. Whorled Rosinweed. Rare: Vernon. Dry, rocky hillside in oak woods.

[*Silphium terebinthinaceum* Jacq.] Prairie Dock. Reported in Transeau and Williams (1929).

Ambrosia trifida L. Great Ragweed. Common weed, especially in bottomlands.

Ambrosia artemisiifolia L. Common Ragweed. Abundant weed in fields and waste places.

Xanthium strumarium L. Cocklebur. Common weed in fields and waste places. Apparently, var. *canadense* (Mill.) T. & G. is more common in county than var. *glabratum* (DC.) Cron.

Helenium autumnale L. var. *autumnale*. Common Sneezeweed. Infrequent: Vernon, Chester, Richland. In moist places, usually along streams.

Helenium nudiflorum Nutt. Purple-headed Sneezeweed. Scarce: 2. Washington—in pasture; near Farmer's Station (KMR).

**Anthemis Cotula* L. Dog Fennel. Common weed around barns and in waste places.

**Achillea Millefolium* L. Yarrow. Common weed along roadsides, in fields and waste places.

**Chrysanthemum Leucanthemum* L. var. *pinnatifidum* Lecoq & Lamotte. Oxeye Daisy. Common along roadsides and in fields.

**Tanacetum vulgare* L. Tansy. Infrequent along roadsides and railroads.

Artemisia ludoviciana Nutt. Western Mugwort. Rare: near Farmer's Station along road, 1934 (KMR).

**Artemisia annua* L. Wormwood. Common weed around barns and in waste places.

Senecio obovatus Muhl. Ragwort. Common in woods.

Senecio aureus L. Golden Ragwort. Frequent in wet places, often in woods.

Erechtites hieracifolia (L.) Raf. Fireweed. Infrequent in moist places.

Cacalia atriplicifolia L. Indian Plantain. Frequent in woods and thickets, mainly in western part of county.

Solidago flexicaulis L. (*S. latifolia* L.). Zigzag Goldenrod. Frequent in woods.

Solidago caesia L. Wreath Goldenrod. Frequent in woods.

Solidago nemoralis Ait. Old-field Goldenrod. Frequent in abandoned and eroded fields.

Solidago patula Muhl. var. *patula*. Rough-leaved Goldenrod. Rare: Adams. In wet seepage area around spring at base of "Bunker Hill".

Solidago ulmifolia Muhl. Elm-leaved Goldenrod. Infrequent in dry woods.

Solidago rugosa Mill. Infrequent: wet places in ITP. Collections include subsp. *rugosa* var *rugosa* and subsp. *aspera* (Ait.) Cron.

Solidago gigantea Ait. var. *gigantea*. Frequent in wet places, especially in ITP.

Solidago canadensis L.

Var. *canadensis*. Canada Goldenrod. Vernon. On dry hillside. Perhaps to be found elsewhere.

Var. *scabra* (Muhl.) T. & G. (*S. altissima* L.) Tall Goldenrod. Abundant along roadsides, in fields, and waste places. This is the commonest goldenrod in county.

Solidago graminifolia (L.) Salisb. var *Nuttallii* (Greene) Fern. Infrequent in moist places, mainly in ITP.

Aster Shortii Lindl. Short's Aster. Scarce: Chester, Vernon. Dry woods in thin soil over limestone.

Aster cordifolius L. Heart-leaved Aster. Frequent in woods.
Aster sagittifolius Willd. Scarce in woods.
Aster patens Ait. Scarce: 2. Vernon. Dry, wooded hillsides. Collections are more or less intermediate between typical variety and var. *phlogifolius* (Muhl.) Nees.
Aster novae-angliae L. New England Aster. Common along roadsides and in moist places.
Aster prenanthoides Muhl. Frequent in moist or wet places.
Aster umbellatus Mill. Flat-topped Aster. Infrequent in clearings and open woods on flats of ITP.
Aster pilosus Willd. var. *pilosus*. Frostweed Aster. Abundant weed in fields and along roadsides. An ecological equivalent of *Erigeron annuus*.
Aster lateriflorus (L.) Britt. Common in woods and thickets.
Aster vimineus Lam. Scarce in ITP: 2. Jefferson. Moist, low place along railroad; moist woods.
Aster praealtus Poir. Scarce: 2. Vernon—gravelly bank of stream; wet meadows near Midland (ELB).
Erigeron philadelphicus L. Fleabane. Frequent in moist or wet places.
Erigeron strigosus Muhl. var. *strigosus*. Vernon—in moist field in ITP.
Erigeron annuus (L.) Pers. Whitetop. Abundant weed in fields and along roadsides.
Conyza canadensis (L.) Cron. (*Erigeron canadensis* L.). Horseweed. Common weed in fields and waste places.
Antennaria neglecta Greene var. *neglecta*. Pussy's Toes. Chester—in field. (Because of taxonomic difficulties in *Antennaria*, no frequency ratings are given).
Antennaria plantaginifolia (L.) Richards. Pussy's Toes, Plantain-leaved Everlasting.
Var. *arnoglossa* (Greene) Cron. Vernon—on wooded ridge.
Var. *ambigens* (Greene) Cron. (A. *fallax* Greene). Chester, Vernon. In field; on wooded hillside.
Gnaphalium purpureum L. var. *purpureum*. Purple Everlasting. Scarce: 3. Jefferson, Vernon. Moist fields in ITP.
Gnaphalium obtusifolium L. Sweet Everlasting. Infrequent in fields.
**Inula Helenium* L. Elecampagne. Infrequent in open woods.
Eupatorium purpureum L. Joe-Pye Weed. Frequent in dry or moist woods.
Eupatorium fistulosum Barratt. Joe-Pye-Weed. Frequent in moist woods.
Eupatorium perfoliatum L. Boneset. Common in moist or wet places.
Eupatorium serotinum Michx. Infrequent in ITP in poorly-drained clearings and open woods.
Eupatorium rugosum Houtt. (*E. urticaefolium* Reich.). White Snakeroot. Common in woods.
Vernonia altissima Nutt. Ironweed. Abundant in fields and bottomlands. Plants from two localities have one character of *V. missurica* Raf. A specimen collected by Vandervort (OSU herb.) from near New Antioch in 1892 was identified previously (Schaffner, 1932) as var. *taeniotricha* Blake; it appears intergradient between *V. altissima* and *V. missurica*.
Elephantopus carolinianus Willd. Elephant's-foot. Scarce: 2. Wilson, Liberty. Disturbed soil in moist woods; clearing in bottomland.
**Arctium minus* Schk. Burdock. Common weed in waste places.
**Cirsium vulgare* (Savi) Airy-Shaw. Bull Thistle. Frequent to common in fields, along streams, and in waste land.
Cirsium discolor (Muhl.) Spreng. Field Thistle. Abundant weed in fields and in a variety of other habitats.
**Cirsium arvense* (L.) Scop. Canada Thistle. Common weed in fields and waste places.
**Centaurea repens* L. Rare: Near New Vienna along railroad, 1939 (KMR).
**Centaurea maculosa* Lam. Spotted Knapweed. Scarce: 2. Green Union. Roadside, field.
**Centaurea Cyanus* L. Cornflower, Batchelor's Button. Rare: near New Vienna along railroad, 1939, (KMR).
**Centaurea Jacea* L. Rare: Union. In field.
Prenanthes alba L. Rattlesnake-root. Rare: Vernon. Dry hillside.
Prenanthes altissima L. Rattlesnake-root. Infrequent to frequent in woods.
Hieracium venosum L. Veined Hawkweed. Scarce: 2. Vernon, Chester. Dry, wooded hillsides.
Hieracium Gronovii L. Rare: Jefferson. Open woods.
Hieracium scabrum Michx. Rough Hawkweed. Rare: Liberty. Dry open place.
**Taraxacum officinale* Weber. Dandelion. Abundant and ubiquitous weed.
**Sonchus arvensis* L. Field Sow Thistle. Near New Vienna along railroad, 1937 (KMR).
**Sonchus asper* (L.) Hill. Spiny Sow Thistle. Infrequent weed in waste places.
Lactuca canadensis L. Wild Lettuce. Infrequent in woods. Collections include var. *latifolia* Ktze. and var. *obovata* Wieg.
**Lactuca Scariola* L. Prickly Lettuce. Common weed along roadsides and in waste places.
**Lactuca saligna* L. Willow-leaved Lettuce. Frequent weed along roadsides and in waste places.
Lactuca floridana (L.) Gaertn. Wild Lettuce. Frequent in moist woods and thickets. Both var. *floridana* and var. *villosa* (Jacq.) Cron. have been collected.

Lactuca biennis (Moench) Fern. Wild Lettuce. Scarce: 3. Jefferson—moist woods; near New Vienna, 1901 (CPI).
**Cichorium Intybus* L. Chicory. Common weed along roadsides and in fields.
Krigia biflora (Walt.) Blake. (*Cynthia virginica* (L.) D. Don.). Frequent in moist woods and in moist, open places.
**Tragopogon pratensis* L. Goat's-beard. Frequent weed along railroads and roadsides.

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A CONTRIBUTION ON THE NATURAL HISTORY OF *ALLOLOBOPHORA MINIMA* MULDAL (LUMBRICIDAE)[1]

WILLIAM R. MURCHIE[2]

Department of Zoology and the Biological Station, University of Michigan, Ann Arbor

Much of what is known concerning life histories of terrestrial Oligochaeta has been derived from laboratory investigations or is based upon a very few species. As late as 1947, Evans and Guild found it necessary in initiating investigations on the relationship of earthworms to soil fertility, to undertake a series of studies on the fundamental biology of earthworms. In their preliminary paper (Evans and Guild, 1947) these authors stated: "In spite of their natural abundance in soils of widely varying types and their supposed value in the economy of nature, extremely little is known of their biology. So, in order to plan experiments on their effects on soil fertility and to interpret the results of these experiments, detailed biological studies were found necessary."

The observations reported here were made during an extended study of the distribution and natural history of Michigan earthworms and, in this instance, are concerned with the species *Allolobophora minima* Muldal, an earthworm not previously reported from North America. This species was described by Muldal (1952) on the basis of material collected in Hertshire, England. There, it occupied a forest soil of moist clay with a heavy cover of matted grass and ivy; it was also found in rough pasture soil under rotting hay. The only North American record is from a single location, namely, a narrow ravine along the Huron River shore about one mile northwest of the city of Ann Arbor in Section 17, Ann Arbor Township, Washtenaw County, Michigan. This population of *A. minima* is nearly confined to a strip of heavy clay loam soil bordering a small intermittent stream which flows through the ravine. Other narrow valleys along the same river were found to have similar vegetation and stream conditions, but none had this clay loam deposit nor individuals of *A. minima*.

The abundance of individual worms remained high throughout the two years this area was kept under observation; as many as 30 specimens having been collected from a single shovelful of soil. Conditions of moisture and temperature are exceptionally stable in this habitat. Seepage occurs throughout the year and in addition, a heavy deposit of leaf litter is present. The soil was never found to be frozen beneath this litter accumulation and soil temperatures above 20° C were not encountered.

Individuals of *Allolobophora minima* are rather small, seldom exceeding 6 cm. in length, most often measuring from 4 to 5 cm. when fully clitellate. They are about 1.5 mm. wide at the clitellum which is slightly opaque and gives a whitish-gray cast to this region of the body. The worm is unpigmented and appears quite delicate due to the thinness of the body wall and its transparency.

A. minima is a true soil species. Its burrows seldom reach the surface but ramify throughout the soil to a depth of at least 12 in. No pattern is evident in the tunneling except for occasional enlargements or chambers which will be described later. In cultures it has been observed to cast on the soil surface. When the soil is dry, small pellets are formed which measure from 0.5 to 1.0 mm. in length and about 0.25 mm. in width. Under moist or wet conditions, the

[1]Part of a thesis completed under the direction of Professor Frank E. Eggleton and submitted in partial fulfillment of the requirements for the Ph.D. degree, University of Michigan.

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THE OHIO JOURNAL OF SCIENCE 55(4): 241, July, 1955.

casts form shapeless masses when deposited on the surface. More commonly casting takes place in the lower soil in which case the fecal material resembles a short cone with a small depression at the blunt apex. In the laboratory, *A. minima* was never observed feeding on the soil surface and it is probable that this worm obtains nearly all of its nourishment from organic material which is nearly consolidated with the soil proper.

Clitellate specimens and viable cocoons were taken during all seasons of the year although the latter were more commonly encountered in the spring and summer months. Individuals placed in culture frames so that their activities could be observed constantly, were found in copulation on two occasions. Inasmuch as conditions for observation were rather poor, it could only be determined that they were partially curled about one another anteriorly and that the anteroventral surfaces were apposed. As described for *Lumbricus terrestris*, the anterior end of each worm was directed toward the clitellar region of the other.

One specimen collected in May, 1952, was found to have spermatophores. These were attached, one on each side, at the level of setal lines *ab* between the 20th and 21st segments. Sections of these structures showed that they were filled with sperm and attached to the worm apparently by means of a band of cuticle. The function of spermatophores for the Oligochaeta is still a matter of conjecture.

The method of deposition of cocoons by this species is rather unusual and a similar process has not been described for any species of earthworm as far as I am aware. *A. minima* produces very small cocoons which measure from 1.5 to 2.0 mm. in length and from 1.25 to 1.75 mm. in width. Tiny projections of approximately equal length extend from either end (fig. 4). The color of the cocoon while the young worm is present varies from pale green to yellow-green and becomes yellow-amber when empty. For the most part, cocoons of the Lumbricidae are merely deposited in the burrows or under debris on the surface of the ground. Cocoon deposition by *Allolobophora minima*, however, is profoundly different. This worm evacuates a small cavity in its burrow of from 5 to 7 mm. in diameter. Within this space the cocoon is deposited, not freely, but encased in a thick layer of rather homogenous soil. Figure 1 shows such a case as found in the soil. Its surface is seen to be covered with slight bumps giving the structure the appearance of a spherical mass of earthworm castings. In the center of this soil mass (fig. 2), a single cocoon is found. Figure 3 demonstrates the relative sizes of the cocoon and the protective earthern capsule. The actual formation of this structure was never observed and it can only be assumed that it represents a deposit of castings placed about the cocoon for protection.

None of the cocoons encountered in this study contained more than one developing individual. After emerging, the young worm burrows directly to the outside of the earthern capsule. The newly hatched worm measures about 14 mm. in length.

During the summer of 1952, specimens of *A. minima* were found in aestivation in the upper soil particularly where the latter had become somewhat dry. Aestivation takes place within a slight enlargement of the burrow which then resembles the chamber evacuated for the cocoon. As with other species of earthworms, the condition is recognizable by the fact that the individual coils into a tight ball and is quite pinkish in color. The addition of moisture will reactivate the aestivating worm almost immediately. No specimens showing either anterior or posterior regeneration were ever collected in the two years this population was under investigation.

Other species of earthworms collected in the same habitat were: *Allolobophora caliginosa*, *Lumbricus rubellus*, *L. terrestris*, *Eisenia rosea*, and *Bimastos tenuis*. Muldal reported *A. caliginosa*, *L. rubellus*, *E. rosea*, and *Allolobophora chlorotica* as associated species in the British collections. It is to be expected that

Allolobophora minima will be found at other points in North America when more extensive collecting has been done. This worm is, however, one of the more demanding species with regard to its habitat requirements, apparently restricted to situations with a high moisture stability. Whether *A. minima* is a species which has been recently imported from Eurasia or represents a relict species from a previous circumpolar distribution of the Lumbricidae cannot presently be determined.

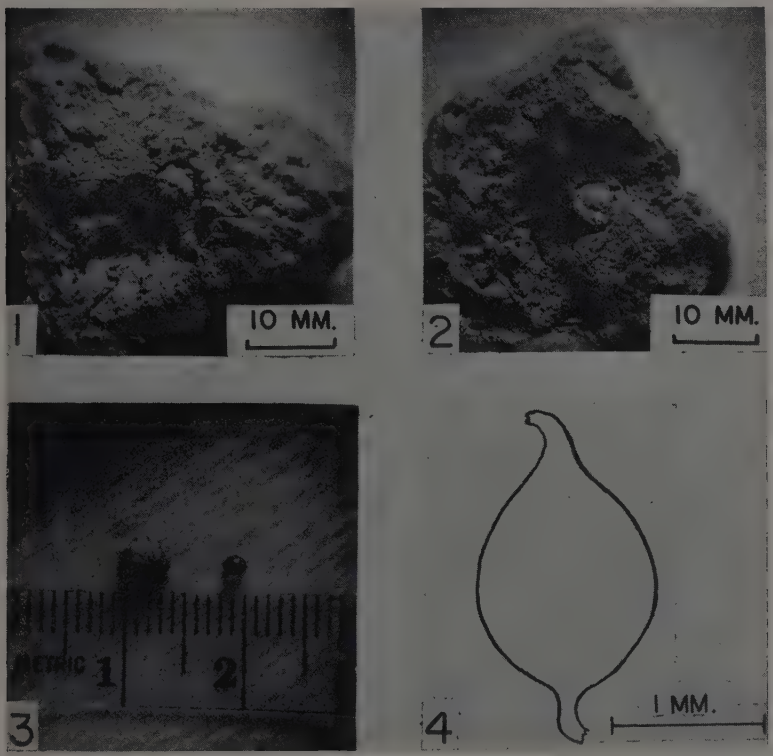

FIGURE 1. Earthern capsule which surrounds cocoon of *A. minima*, shown partially exposed within the soil mass.

FIGURE 2. Cocoon of *A. minima* with portion of earthern capsule removed.

FIGURE 3. Earthern capsule and cocoon of *A. minima*. Structure on left is capsule before removal of coon. An example of latter is shown on the right.

FIGURE 4. Sketch of cocoon of *A. minima*.

SUMMARY

Salient features of the life history and biology of *Allolobophora minima* Muldal are presented. This species is a true soil form, apparently restricted to heavier soils with a high moisture stability. Viable cocoons are found throughout the year. These cocoons are encased in a capsule of soil, the latter apparently composed of cast material placed about the cocoon for protection. Cocoon and soil

capsule are placed in a small chamber evacuated in the burrow. Only one embryo develops in each cocoon. Aestivation is typical and induced by dry soil conditions. No naturally regenerating individuals were observed in two years of field study. *A. minima* has not been reported previously from North America.

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Mudal, S. 1952. A new species of earthworm of the genus *Allolobophora*. Proc. Zool. Soc. London 122: 463–465.

Cryptogamic Botany. Volumes I and II. *G. M. Smith*, Editor. McGraw-Hill Book Company, Inc., New York. Second Edition, 1955. Volume I, v +546 pp. $8.50, Volume II, v + 399 pp. $8.00.

The Second Edition, while retaining the valuable features of the original, has been materially improved by more complete group discussions, the use of new examples and the redrawing of many figures.

Some presumably will consider the treatment to be too detailed for use as a text except by advanced students. There is, however, a wealth of information for students at all levels.

The work, because it presents the subject by means of "Types" allows the instructor a wide latitude in the selection of material. It provides a plan which may be taught as is, or for the more enterprising teacher, it represents an outline to which may be appended varied examples of his choice.

For those who may consider the details beyond their required level of interpretation, the work will be a welcome reference, for both personal and class use.

C. E. Taft

Climatic Atlas of the United States. *Stephen S. Visher.* Harvard Press, Cambridge. 1954. xii + 403 pp. $9.00.

This is a book of 999 maps and 32 diagrams dealing with manifold phases of climate in the United States. It is the first generalized account of climatic elements to be published since the 1941 Yearbook of Agriculture: Climate and Man.

The data from measurement of five major weather elements form the basis for the generalizations. The first section on temperature contains 369 maps; wind, 56 maps and 2 diagrams; sunshine, 22 maps and 1 diagram; humidity and evaporation, 36 maps and 2 diagrams. Various calculations concerning precipitation are delimited on 417 maps.

Sections VI consists of maps augmented by graphs and tables and deals with certain consequences of climate and weather on agriculture, health, land, water, and soil erosion. A final section attempts to delimit climatic regions.

One is impressed by the infinite number of combinations into which climatic data of a single weather element can be put to form bases for maps. It seems likely that most general questions concerning mappable climatic elements in the United States can be answered by reference to this volume.

John N. Wolfe

Mosquitoes Their Bionomics and Relation to Disease. *William R. Horsfall.* The Ronald Press Co. New York. 1955. viii + 723 pp. $16.00.

Although the literature dealing with mosquitoes is extensive this volume is excellent proof that knowledge of the biology of most species is still fragmentary. The reader can quickly get an appreciation of the size of Dr. Horsfall's efforts by examining the approximately eighty pages of bibliography with citations in condensed form so that most references require only a single line.

The information on bionomics and disease relationships is arranged in uniform fashion for all life history stages under species names. Much data are given in tables of which there are over two hundred. The index of genera and species makes it easy to locate information about any species but the general index is short and of little help in locating data which are scattered throughout the book. Scanning the pages for particular information is quite easy and we have already covered the book several times seeking data on special topics. Rather than complain about what the author might have done or point out a missing reference or two, or incomplete coverage of included references, and problems of synonomy, it is more proper that we be grateful to him for helping us so much.

This volume will stimulate much research on mosquito biology and I suspect this will be Dr. Horsfall's greatest reward for a lot of very hard labor.

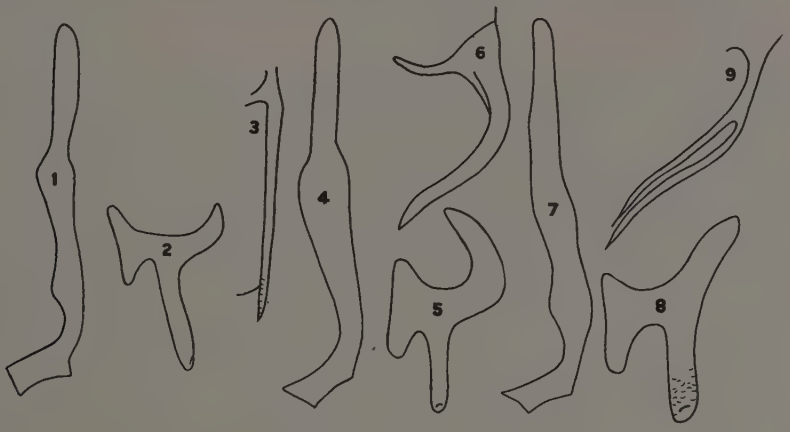
Carl Venard

SOME NEW TEXAN ERYTHRONEURA (ERATONEURA) OF THE DIRA GROUP (HOMPOTERA: CICADELLIDAE)

DOROTHY J. KNULL

Department of Zoology and Entomology, The Ohio State University, Columbus 10

Erythroneura of many species were swarming on new elm leaves in Huntsville State Park, Walker Co., Texas, April 2, 1954, where they were collected by D. J. and J. N. Knull. Among them were three new species of the Dira Group.



EXPLANATION OF FIGURES

In the three numbers given for each species, first applies to style, second to lateral view of aedeagus, and third to pygofer hook.

Erythroneura (*Eratoneura*) *longa* n. sp. 1, 2, 3.
Erythroneura (*Eratoneura*) *robusta* n. sp. 4, 5, 6.
Erythroneura (*Eratoneura*) *schista* n. sp. 7, 8, 9.

The color markings in all three are orange and lightly joined, and of the usual pattern of this subgenus. Figures of the inner ♂ genitalia portray the distinguishing features of these new species. All type material is deposited in the collection of the author.

Erythroneura (Eratoneura) longa n. sp.

Figures 1, 2, and 3.

Near *E. patris* Ross and DeLong (1953) but with straight pygofer hook and broader toe on foot of style. Black dots on elytra small and round. Length 2.6 mm.

Holotype ♂ and two paratypes.

Erythroneura (Eratoneura) robusta n. sp.

Figures 4, 5, and 6.

Near *E. immota* Beamer (1932) but with short, thick, incurved pygofer hook, not swollen on outer two thirds, but almost parallel-sided to sharp tip. Length: 2.6 mm.

Holotype ♂ and sixteen paratypes.

Erythroneura (Eratoneura) schista n. sp.

Figures 7, 8, and 9.

Near *E. millsi* Ross and DeLong (1950) but with outer prong of pygofer hook a little longer than inner, and with more robust foot of style. Length: 2.8 mm.

Holotype ♂, allotype and six ♂ paratypes.

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Beamer, R. H. 1932. Erythroneura of the Maculata Group. Can. Ent. 64: 16–17.
Ross, H. H., and **DeLong, D. M.** 1950. New Species of Erythroneura of the Maculata Group. Ohio Journ. Sci. 50: 291.
———, and ———. 1953. Biological and Taxonomic Notes on Erythroneura. Ohio Jour. Sci. 53: 77–90.

Evolution of the Vertebrates. *Edwin H. Colbert.* John Wiley & Sons, Inc., New York. 1955. xiii+479 pp. $8.95.

The author states in his preface that "this is primarily a survey of the fossil record of backboned animals" . . . and "is intended to be a general textbook on vertebrate paleontology for the general student rather than for the specialist." By "general student" he apparently means either one who is interested in all aspects of vertebrate Zoology, or one who is particularly concerned with the evidences of organic evolution. For either type of student, the book is a valuable and readily usable contribution in its broad treatment of the main lines of vertebrate phylogeny.

After a rather sketchy introduction to primitive living chordates and to the earliest known fossil forms as possible ancestral types, the text gets on firmer ground with the "Appearance of Placoderms." From here, the author is particularly adept in relating the past with the present; i.e., in describing fossil ancestral forms with direct reference to the histories and fates of their descendents still existing and extinct. Frequent comments on conditions of the environment, the size and habits of the animals, together with excellent and numerous illustrations combine to make the book stimulating and attractive. W. JAMES LEACH

Aspects of Deep Sea Biology. *N. B. Marshall.* Philosophical Library, Inc., New York. 1954. 380 pp. $10.00.

This beautifully illustrated and printed book serves as an introduction to the biology of the deep sea. Serious study of this part of the sea extends back only 81 years and there have been periods of inactivity since then, but in recent years there has been an upsurge of interest by biologists, other scientists, and the general public. Aspects of Deep Sea Biology will interest all people who wish to have a general education about the deeper regions of two-thirds of the earth's surface.

The chapter titles indicate the scope of subject matter and they are: The growth of deep sea biology, Means of exploring the ocean, The deep sea environment, Oceanic plants, Animal life in the deep sea, Deep sea food chains, Vertical patterns of mid-water life, counteracting gravity, The sense organs of deep sea fishes, Deep sea sound, Living light in the deep sea, Life histories, and Some aspects of marine biogeography.

These titles however do not indicate satisfactorily the historical approach the author has used and his emphasis on methods of exploring the depths and his leaving the reader not only with the current status of the subject but also with the realization that numerous problems remain to be solved. It is easy to agree with the author that, "The ocean is full of surprises, particularly for those who make up their minds too quickly".

Each chapter has a list of references. Five plates are colored, line drawings are numerous, and there is an index. CARL VENARD

Skyshooting. *R. Newton Mayall* and *Margaret L. Mayall.* The Ronald Press Company, New York. 1949. xi + 174 pp. $4.00.

"Skyshooting" is a hobby which blends two other hobbies: amateur photography and amateur astronomy. This book is thus directed to two wide but generally separate audiences. It exhorts, on the one hand, the camera fan to look skyward for new and exciting subjects for his insatiable camera, and on the other, the amateur astronomer, already familiar visually with sky objects, to capture these wonders with a camera.

The authors succeed in addressing both audiences. They give the practical know-how and explicit and understandable directions for photographing the wealth of stars and galaxies, the planets, sun and the moon, as well as flashing meteors and delicate aurorae. Expensive equipment is fine if you have it, but a simple "Brownie" will do. Knowledge of astronomy is not needed, but it helps.

The book can be recommended for the amateur astronomer and the amateur photographer alike. J. A. HYNEK

ANNUAL REPORT OF THE OHIO ACADEMY OF SCIENCE

1955

Organized 1891 Incorporated 1892

Affiliated with the American Association for the Advancement of Science

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Nominating

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THE OHIO JOURNAL OF SCIENCE

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REPORT OF THE SIXTY-FOURTH ANNUAL MEETING OF THE OHIO ACADEMY OF SCIENCE

The sixty-fourth annual meeting was held on the campus of Ohio Wesleyan University at Delaware on April 21, 22 and 23, 1955. The executive committee met at 3 P.M. and the council met at 8 P.M. in the Faculty Lounge of the Memorial Union Building.

On Friday ten sectional meetings were held for zoology, plant sciences, subsection on genetics, geology, medical sciences, physics and astronomy, geography, chemistry, science education, anthropology and sociology, and conservation. The Ohio Section of the American Physical Society met in joint session with the section in physics and astronomy. The seventh annual state science day of the Ohio Junior Academy of Science was held the same day with a record number of student projects on display. Commercial exhibits were presented by four companies. On Friday afternoon the wives of faculty members in the science departments of Ohio Wesleyan University served tea to the visiting ladies. An invitation was extended to all guests to attend one of the performances of Shakespeare's play, "The Tempest," which was presented each evening during the conference. Two sections, Geology and Conservation, held field trips on Saturday.

The annual banquet and business meeting were held in the dining room of Stuyvesant Hall at 6:15 P.M. Dr. C. E. O'Neal, honorary chairman of the local committee on arrangements, served as toastmaster. Greetings from Ohio Wesleyan University were given by Dr. C. E. Ficken, Interim President, and the response for the academy was given by Dr. R. A. Hefner. The presidential address, entitled "Some Biological Factors in Aging," was delivered by Dr. Rush Elliott.

The Secretary announced the following as newly elected fellows of the academy:

ATZENHOEFFER, D. R.
BARNES, W. H.
BLOCK, M. L.
BOND, R. H.
BOYCE, S. G.
DAVIS, R. K.
DICKMAN, I. I.
DREIVELBIS, F. R.
ESTEL, L. A.
FORSYTH, JANE L.
GAMBILL, W. G.
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GOSLIN, R. M.
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MCKNIGHT, CLARENCE
MORSE, H. H.
NESSLE, J. P.
PORTER, H. L.
SHANK, J. R.
STEELE, C. O.
SMITH, W. H.
SWANSON, C. G.
SWINEBROAD, JEFF
VERMILLION, M. T.
WARNER, D. C. (posthumous)
WELTON, MISS EVELYN
WILCOX, J. A.
WINSLOW, J. D.
WOLFROM, M. L.

Mr. R. E. McKay, executive secretary of the Junior Academy of Science, announced the annual awards to outstanding high school teachers and the Kroger awards for outstanding work in science for a school in each district.

The Secretary presented the report of the Nominating Committee. Nominations were presented for the following offices: president; secretary; treasurer; director of public relations; librarian; member of library committee, publications committee, and academy representative on the Ohio Journal of Science; member of necrology committee; member of resolutions committee; and member of trustees of research funds. The newly elected officers are listed in the roster given earlier in this report.

The report of the resolutions committee was given by Dr. W. A. Manuel.

Respectfully submitted,

R. W. DEXTER, *Secretary*

REPORT OF THE EXECUTIVE COMMITTEE AND COUNCIL

The executive committee met on December 3, 1954, and again on April 21, 1955; the council met on December 4, 1954, and again on April 21, 1955. The fall meetings were held at Ohio State University while the spring meetings were held at Ohio Wesleyan University. Numerous matters of business were discussed at these meetings. Following is a brief summary of some of the more important actions taken. Previous arrangements for our annual meetings were interchanged so that the annual meeting for 1956 was scheduled for Wittenberg College and the meeting for 1957 scheduled for Bowling Green State University. Eight graduate students in the field of genetics were given a complimentary membership in the academy for one year. These memberships were paid by a gift from C. M. Goethe. Dr. Wave Shaffer was appointed as director of public relations. Mrs. Ethel M. Miller and Dr. Frederick H. Krecker were elected as honorary life members. The treasury of the Junior Academy of Science was united with that of the senior academy so that all financial business would be transacted through the treasurer of the academy. It was decided to leave our research funds deposited in the First Federal Savings and Loan Association as now invested. Chairmen of all committees gave their annual reports, a digest of which will be found elsewhere in these pages.

The matter of certification of science teachers in Ohio was discussed at some length. A report by Conrad E. Ronnenberg entitled, "New Requirements for Provisional Teaching Certificate in Science in Ohio," has been published in *The Science Teacher* for March, 1955. A resolution presented by Roscoe Franks to oppose the use of bait in hunting migratory waterfowl was adopted.

The total membership of the Academy as of April 21, 1955, was 1223 distributed among the sections as follows: Zoology 289; Plant Sciences 203; Geology 175; Medical Sciences 111; Physics and Astronomy 67; Geography 49; Chemistry 111; Science Education 86; Anthropology and Sociology 28; and Conservation 104. The 1956 annual meeting was scheduled for Wittenberg College, Springfield, Ohio, on April 19, 20, and 21.

Respectfully submitted,

RALPH W. DEXTER, *Secretary*

REPORT OF THE TREASURER

CURRENT EXPENSE FUND
Fiscal Year 1954

RECEIPTS:	
Bank Balance, January 1, 1954	$3,380.04
Membership Dues	4,314.00
Sale of Publications	6.42
Interest U. S. Savings Bonds	47.50
Exhibitor Fees (Commercial)	75.00
Gift (Goethe)	25.00
Refund on cost of U. S. Treasury Bonds	6.88
Miscellaneous	75.10
	$7,929.94
EXPENDITURES:	
Subscriptions and Engraving Ohio Journal of Science	$2,847.93
Office Supplies and expense	224.97
Printing Annual Report	82.04
Printing Newsletter, Junior Academy	266.75
Programs for Annual Meeting	156.50
Postage, office supplies, bank charges and other administrative expense	436.79
Printing announcements	56.00
Academy Conference	5.00
Bank Balance, December 31, 1954	3,853.96
	$7,929.94

OHIO ACADEMY OF SCIENCE RESEARCH FUND

Fiscal Year 1954

RECEIPTS:	
Bank Balance, January 1, 1954	$197.33
Interest on Savings Account	18.99
Interest U. S. Bonds	7.50
Dividends, Banc-Ohio Stock	32.50
Grant A.A.A.S.	190.00
	$446.32
EXPENDITURES:	
Grant. Elizabeth W. Smith	$ 50.00
Grant. Thos. D. Howe	40.00
Grant. Peter Chacharonis	100.00
Bank Charges	3.48
Bank Balance, December 31, 1954	233.85
	$427.33
Interest on Savings Account. Still in Savings Account	18.99
	$446.32
Excess Income over Expense	$ 55.31

Respectfully submitted,

ROBERT M. GEIST, *Treasurer.*

REPORT OF THE TRUSTEES OF THE RESEARCH FUND

Fiscal Year 1954

Bank Balance	$197.33
Interest Savings Account	18.99
Interest U. S. Bonds	7.50
Dividends Banc—Ohio Stock	32.50
Grant A.A.A.S.	190.00
Total Receipts	$446.32
EXPENDITURES:	
Grant, Elizabeth W. Smith, life histories of non-cave dwelling bats	$ 50.00
Grant, Peter Chacharonis, Protozoa of sphagnum bog at Buckeye Lake	100.00
Grant, Thos. D. Howe, woody plants of northwestern Ohio.	40.00
Bank Charges	3.48
Interest Savings Account. Still in Savings Bank	18.99
Bank Balance December 31, 1954	233.85
Total Expenditures	$446.32
Examination will show excess income over expense	$ 55.51

The following grants, made in 1955, will appear in the fiscal report for that year:

Harold G. Multer, rock thin sections, Wayne County	$ 35.00
Ohio Flora Committee, expenses of committee	212.00
John R. Coash, glacial stratiography of northwestern Ohio	100.00
Robert E. Woodruff, distribution of Scarabaeidae (Coleoptera) in Ohio	50.00
	$397.00

Respectfully submitted,

RICHARD P. GOLDTHWAIT,
GLENN W. BLAYDES,
EDWARD S. THOMAS, *Chairman*

REPORT OF THE LIBRARIAN FOR 1954

The librarian is pleased to inform the Academy that its official journal is used in five hundred and twenty-four exchanges. Seventy-two percent of these exchanges are with institutions located abroad. Twenty-eight percent of these exchanges are with domestic institutions.

There has been a 5.2% increase in the number of exchanges since the Librarian's previous report. Twenty-six exchange agreements were concluded, resulting in the addition to the library of forty-nine new periodicals.

Exchange Agreements Concluded Between the O.A.S. and Domestic and Foreign Institutions

	April 1954	April 1955	Numerical Gain	Percent increase over 1954
Domestic exchanges	144	148	4	2.7%
Foreign exchanges	354	376	22	6.2%
Total number of exchanges	498	524	26	5.2%

Sales of the Academy's publications for the period July, 1954 through April, 1955 amounted to twenty-four dollars and twenty-five cents ($24.25). This sum was turned over to the Treasurer of the Academy.

Respectfully submitted,

MORTON COBURN, *Librarian*

REPORT OF THE JOINT ADMINISTRATIVE BOARD OF THE OHIO JOURNAL OF SCIENCE

The annual meeting of the Joint Administrative Board of the Ohio Journal of Science was called for April 11, 1955. Present were Drs. Spieker and Meyer representing the Ohio State University, and Drs. Bõhning, Popham, and Fisk of the Ohio Journal of Science staff.

Since neither Academy representative was present, the ensuing discussion of the affairs of the Journal was informal and unofficial.

The reports of the business manager, editor, and book review editor were read and copies were sent to the Academy representatives. The reports were approved by all members of the board (voting orally and by mail ballot). Copies of the reports are appended to these minutes. The editor indicated that he is now operating with an optimum (six months) supply of manuscripts on hand. The business manager stated that the editor may increase the size of the Journal at any time it becomes necessary to reduce the size of the backlog of approved manuscripts to an optimum number.

The present board chairman (Dr. Spieker), editor (Dr. Bõhning), business manager (Dr. Popham), and book review editor (Dr. Fisk) were elected by the board (voting orally and by mail ballot) to serve for the year of 1955–1956.

The board approved (voting orally and by mail ballot) a flat charge of $1.00 for each back copy of the Journal. Effective prices established October 15, 1949 were $1.00 per copy or $4.00 per volume.

A suggestion to bind one set of the Ohio Journal of Science for use of the Journal staff was approved by the board (voting orally and by mail ballot).

Respectfully submitted,

RICHARD A. POPHAM
Secretary of the Board

THE OHIO JOURNAL OF SCIENCE

Volume 54—Fiscal Year 1954

BALANCE SHEET
(With comparison with previous Two Years)

	Volume 52 Fiscal Year Jan. 1, 1952 Dec. 31, 1952	Volume 53 Fiscal Year Jan. 1, 1953 Dec. 31, 1953	Volume 54 Fiscal Year Jan. 1, 1954 Dec. 31, 1954
RECEIPTS:			
Bank balance at beginning of period	$1,370.64	$1,566.51	$1,928.65
O. S. U.—paid for subscriptions	2,000.00	2,500.00	2,500.00
O. A. S.—paid for subscriptions	2,135.00	2,069.50	2,035.50
Non-members—paid for subscriptions	386.00	432.50	354.50
Separate numbers, volumes and reprints sold	222.30	657.15	393.85
50 year index sold	0.00	555.00	197.50
O. A. S.—paid ½ cost of plates	231.14	237.84	312.43
O. A. S.—paid for annual report	103.32	136.28	82.04
Miscellaneous	17.50	34.94	597.57
Advertisements	737.52	387.00	280.68
Charles F. Kettering Foundation—Gift	0.00	0.00	500.00
	$7,203.42	$8,576.72	$9,182.72

EXPENDITURES			
Spahr and Glenn—printing O. J. S.	$4,544.00	$4,843.80	$5,119.80
Bucher Engraving—plates	585.20	624.86	606.13
Postage and express	214.57	281.50	237.73
Secretary and labor	48.50	125.06	91.08
Office expenses and bank charges	94.64	61.86	85.73
Advertising in the O. J. S.	150.00	213.89	0.00
Reprints	0.00	236.89	24.00
Mailing envelopes	0.00	225.77	0.00
Refunds	0.00	0.00	3.00
Miscellaneous	0.00	34.44	597.57
Bank balance at end of period	1,566.51	1,928.65	2,417.68
	$7,203.42	$8,576.72	$9,182.72
Cost of supplying one volume of six numbers	$2.891	$3.085	$3.046

THE OHIO JOURNAL OF SCIENCE

REPORT OF THE EDITOR OF VOLUME 54, 1954,
to the Joint Administrative Board
April 11, 1955

Volume 54 of The Ohio Journal of Science contained 440 pages of which 398 pages were devoted to 65 scientific papers in nine fields of science (designated by sections of The Ohio Academy of Science) and 42 pages to announcements, book notices, advertising, and index.

Respectfully submitted,
R. H. BÖHNING, *Editor*

REPORT OF JUNIOR ACADEMY OF SCIENCE ACTIVITIES

This report culminates the first year's activities of the Executive Secretary since taking over from Dr. Krecker in 1954.

I am not aware of the number of scholarships that were awarded at the close of the 1954 Science Day nor how many students made application for scholarships.

On September 10 and 11, 1954, a meeting of the Junior Academy Council convened at Bowling Green State University for an over-night session to discuss problems and policy for 1955. Approximately 22 persons were present and a very successful meeting was held. This meeting eliminated the necessity of having the regular October Council meeting, but one was held in January, 1955.

The District Science Days for 1955 were held as follows with the numbers present:

March 26, 1955	Muskingum	104
April 2, 1955	Ohio University	145
	Bowling Green	772
	Kent State	407
	Wittenberg	119
	Ohio State	385
April 16, 1955	Miami	338

There was a total of 2268 students in all grades from 7 through 12. The total registration for the State Science Day on April 22, is approximately 350.

During the present year, the Kroger Company has increased the number of awards to schools to 7, one for each District.

We are hoping that in the near future we can approach other industries to make similar awards in order to encourage high school students to go into the Sciences.

One of the most serious problems that we must meet in both the District Science Days and the State Science Day is that of securing judges. I want to thank the various sectional vice-presidents for their cooperation in helping me secure college judges for the State Science Day and I sincerely hope I can have all future vice-presidents cooperate in this regard. We shall attempt to diminish, as nearly as possible, the number of entrants in the State Science Day in order for these judges to attend their sectional meetings.

These are the main items of interest as reviewed for the past year. I am very happy to have the very fine cooperation of all the officers of the Senior Academy and I sincerely hope I may have their continued help.

Respectfully submitted,

ROBERT E. MCKAY
Executive Secretary

THE OHIO FLORA COMMITTEE

The Ohio Flora project has progressed significantly during the past year. The principle accomplishments are as follows:

1. A "Preliminary List of the Grasses of Ohio" by Dr. Clara Weishaupt was prepared and distributed in June, 1954.

2. Work on the Legumes of Ohio by Dr. William Gambill was continued to the point that a preliminary list is now almost ready for distribution.

3. A Preliminary list of the Pteridophytes of Ohio by William Adams is now ready for mimeographing.

4. Manuscripts on *Crataegus* by Dr. E. J. Palmer and *Salix* by Dr. C. R. Ball are nearly ready for publication.

5. Collection of specimens and of herbarium slips has continued in significant volume.

Respectfully submitted,

J. Arthur Herrick
Secretary, Ohio Flora Committee

REPORT OF COMMITTEE ON RESOLUTIONS

Be it Resolved, that we the members of the Ohio Academy of Science express our sincere appreciation and thanks to our hosts, Ohio Wesleyan University, and especially to the members of the host committees, who provided the facilities and the efficient organization which enabled our sessions to proceed smoothly and pleasantly.

Be it further Resolved that we the members of this Academy express to Dr. R. M. Geist our gratitude for his very fine work as Treasurer of the Academy, and that we extend our best wishes to him as he completes seven years of distinguished service in this office and transfers his interests more completely to his subject matter area, Section A.

Respectfully submitted,

J. W. Gebbart
W. H. Shideler,
W. A. Manuel, *Chairman*

REPORT OF THE NECROLOGY COMMITTEE

This report covers the period from April, 1954 to April, 1955 and records the passing of members of the Academy in that interval.

Charles Clemon Deam

Botanist of Indiana and former Indiana State Forester and author of Trees of Indiana. Member of The Ohio Academy of Science from 1906–1953.

Mr. Deam was born at Bluffton, Indiana on August 30, 1865 and lived most of his life in that town. He attended De Pauw University for two years until 1887 when he became a railroad surveyor and later a pharmacist. In 1891 he bought a drug store in Bluffton which he retained as long as he lived in a successful business with a partner. His interest in plants stemmed from pharmacy but he later took trips to Mexico and Guatamala for botanical exploration with a party of scientists from Ohio State University in 1904 when he collected 438 species. In 1909 another trip to tropical America was made and in the same year he was appointed by the Governor of Indiana to the newly created board of Forestry. In this position he started the State Forestry Reservation in Clark County and installed modern forestry practice by farmers all over the state. In 1911 he published the *Trees of Indiana*, one of his major works. The 5th. Edition being published in 1953. He served as State Forester until 1928 and after that as Research Forester and remained active in publishing some works and revising old works until his death. In 1940 his work was reviewed and collected by the Indiana State Department of Conservation and published as the *Flora of Indiana*.

Mr. Deam was honored by many learned and academic bodies. In 1920 he received an honorary A.M. by Wabash College, 1932 honorary D.Sc. by De Pauw, in 1939 honorary LLD by Indiana University and an honorary banquet by the city of Bluffton in 1938. In 1940 he was awarded the Pugsley medal by the Historical Society of New York and a certificate of Distinction from Purdue University in 1944. A second celebration of Appreciation was held by the city of Bluffton in 1952. On May 29, 1953 Mr. Deam died of the infirmaties of age and was interred in Six Mile Cemetery at Bluffton. In 1893 he had married Stella Mullin, a teacher in Bluffton Schools, and by whom he had a son who died in infancy and a daughter, Roberta Elizabeth Deam Ortenburger. Mrs. Deam preceded her husband in death by a month. She was his constant helper in his arduous botanical researches and he named 3 species of plants for her. There is published a long list of new plants from the American tropics and many new species in Indiana discovered by Mr. Deam as well as a list of 33 rusts collected in Indiana. He has been honored by membership in 26 scientific societies.

Dr. William Lloyd Evans

Professor of Chemistry at Ohio State University from 1905 to 1941. Member and Fellow of the Chemistry Section.

Prof. Evans was born in Columbus, Ohio on December 22, 1870 and educated in the public schools of the city and was graduated with the Bachelor of Science degree from Ohio State University in 1892 taking his major in chemistry. After a short period of employment as chemist for a Columbus Tile Company, he returned to the University's Graduate School and secured a Master of Science degree in 1896. A few years later he received the Ph.D. degree from the University of Chicago in 1905. From 1898 to 1902 he had been instructor in Chemistry in a high school and while at Chicago he was occupied as a Fellow in Chemistry. After securing the degree at Chicago he returned to Ohio State University as assistant Professor of Chemistry in 1905 and then was made head of the Department from 1928 to 1941 when he became emeritus professor. During World War I Dr. Evans served as a Captain in the Reserve Officers Corps in 1917. Dr. Evans was a prolific writer as well as an inspiring teacher. In his long career as Professor of Chemistry at Ohio State University he wrote numerous textbooks and Laboratory Manuals for chemistry as well as many articles in the chemistry journals. One unique publication was his popular song book collection called "Songs of Ohio State University."

Many honors came to Dr. Evans. He served as president of the Ohio Academy of Science in 1939 and 1940. He was a Fellow of the A A A S and Vice-President of the Chemistry Section in 1933–34. He was elected into Phi Beta Kappa, Sigma Xi and received the William Nichols Medal in 1929. The medal of the Amer. Institute of Chemists in 1942 and an honorary Doctor of Science from Capital University in 1939.

In 1911 Dr. Evans married Cora Ruth Roberts and to them were born three children, Lloyd Robert Evans, M.D., Jane Ann Evans Nielsen and William Arthur Evans Lt. jg. deceased in World War II.

Dr. Evans died of pemfigus on Oct. 18, 1954 and was buried in Green Lawn Cemetery, Columbus, in his 84th year.

Dr. Herbert Osborn

Zoologist and Entomologist at Ohio State University from 1916 to 1933—Fellow of the Zoology Section.

Dr. Osborn was born March 19, 1856 at LaFayette, Wisconsin and received the B.Sc. degree at Iowa State College in 1879, the M.Sc. in 1880. From 1897 to 1898 he served through the ranks of instructor to Professor of Zoology and Entomology at Iowa State College and from 1890 to 1898 as Iowa State Entomologist.

In 1916 he transferred to Ohio State University as Professor of Zoology and Entomology where he remained until he became emeritus in 1933. He was Director of the Lake Laboratory from 1898 to 1918 and Director of the Ohio Biological Survey since 1912 and from 1885 to 1894 he was a special agent in entomology for the U. S. Dept. of Agriculture. Since 1913 he was a consultant of the Maine Expt. Station and Consulting entomologist to the Tropical Plant Research Foundation and a Collaborator of the U. S. Bureau of Entomology since 1930.

Dr. Osborn was a Fellow of A.A.A.S. and Vice-Pres. of Section F in 1917; President of the Iowa Academy of Science in 1887 and Editor of the Proceedings from 1890 to 1898; President of the Assn. of Econ. Entomologists in 1898; of the Ohio Academy of Science in 1904–05 and of the Amer. Microscopical Soc. 1907–1909 and the Entom. Soc. of Amer. in 1911. Editor of its Annals from 1908 to 1928. Trustee of Biological Abstracts 1927–1937 and Trustee of the Research Fund of the Ohio Acad. Sci. since 1917. He was author of too many books and articles on insects to list here, but his most important were contributions to economic entomology.

Dr. Osborn received honorary membership in many foreign entomological societies and was a member of Sigma Xi, Phi Kappa Phi, Alpha Zeta, Gamma Alpha. In Columbus he was a member of the University Club and the Faculty Club.

In 1883 Dr. Osborn married Alice I. Sayles and to them were born two sons, Morse F. Osborn and Herbert Y. Osborn and three daughters, Evelyn Osborn Knapp, Dorothy Osborn Bagg and Margaret Osborn Lounsbury. All of whom survive him.

On Sept. 20, 1954, this most distinguished scientist and best beloved biologist of Ohio passed away due to a coronary thrombosis and was buried in Columbus, Ohio in his 98th year

Henry Clyde Shetrone

Curator of the Archeological Museum at Ohio State University and Fellow of the Anthropology Section of the Academy of Science.

Dr. Shetrone was born on August 10, 1876 at Millersport, Ohio and attended college for a few years at Denison University. He became interested in the archeology of Ohio especially the culture of the Mound Builders and was an active member of the Ohio Archeological Society and the Ohio Historical Society. In 1905 he married Miss Tillie May Klinger, but to this marriage accrued no issue.

In 1921 he became curator of the Archeological Collection in the Ohio State Museum which position he held until 1928. Then he was appointed Director of Ohio State Historical Society housed in the Ohio State Museum at Columbus. He served in this capacity until 1946.

Mr. Shetrone was distinguished with an honorary Master of Arts from Ohio University at Athens, in 1929 and an honorary Doctor of Science from his alma mater, Denison University, in 1944. He was a Fellow of the American Association for the Advancement of Science and a Fellow of the American Anthropological Association.

He served the Ohio Academy of Science as a president and as a member of the Council of the Association of American Museums. He was also a member of the Ohio State Chapter of the Sigma Xi. Mrs. Shetrone died sometime prior to Dr. Shetrone's death which occurred on November 23, 1954 of a cerebral hemorrhage. His remains were interred in Columbus, Ohio. The greater part of his life of 78 years was given to the conservation of the archeological relics found in Ohio.

David Clark Warner

Water Conservation, Consultant for State of Ohio from 1912 to 1954—Member of Section J. (Conservation) in 1952—elected Fellow Posthumously in 1954.

Mr. Warner was born in Central New York State on Dec. 5, 1872 but moved to Logan County, Ohio with his parents at an early age. His youth was interesting and checkered with attempts at scientific experiments such as building an experimental telegraph line along White Oak Creek near Higginsport, Ohio and converting water power to electricity to operate it.

In 1892 he completed a course at Buffalo State Normal School and received a teaching certificate. However, he never seems to have held a teaching position. Intrigued by scientific exhibits he received a position as a special policeman at the Panama Exposition in 1900 in Buffalo due he claims to influence of Pres. Theodore Roosevelt in his behalf. In 1904 to 1906 he was a special policeman at the St. Louis World's Fair but in 1912 he was on the city police force of Columbus, Ohio and active as a lobbyist for water conservation in the State legislature. He is said to have often appeared before committees to speak for a special bill in which he was interested in his policeman's uniform. In 1917 he associated himself with the Y.M.C.A. and was sent to Paris with the U. S. troops in World War I. Here he met a famous Parisian tenor with whom he studied music. After the war he returned to America and associated himself as a singing evangelist in Chicago with Dwight L. Moody.

He returned to Columbus and Ohio where he remained for the rest of his life. In 1912 he had helped pass legislation on reforestation and legalizing Conservation Districts. He was one of the co-authors of the bill setting up the Ohio Conservancy Act in 1913. He remained active in water conservation promotion and was Executive Secretary of the Ohio Water Conservation Board from 1931 to 1936. He served as Consultant to the Muskingham Conservancy District and was author of the Ohio Farm Pond Law in 1937. With a change in political administration he was ousted by the Governor from his position but he defied the governor and retained an office in the State House. When light and telephone service were cut off he paid the bills himself, but continued to promote water conservation without pay for his services. In 1941 a happy political turn restored him again to his position as Executive Secretary for the Water Conservation Board and Counselor of Public Works in 1949.

Mr. Warner was made an honorary member of Friends of the Land and honorary life member of the Ohio Forestry Association and an honorary member of both the National Society of Professional Engineers and the Ohio Society of Professional Engineers. He is referred to in the Annual Report of the Ohio Conservation Commission as "The Father of Water Conservation in Ohio" and more particularly as the "Promotor of Watershed Conservancy Districts."

Mr. Warner's private life is not too well known. He had married and was the father of three children, viz. Henry Warner, who owned and operated the Columbus testing laboratory, John Warner, a teacher in South High School, Columbus and Miss Helen Warner, a nurse by profession.

On March 14, 1955, this great exponent of Conservation, who battled for the welfare of Ohio under great obstacles and discouraging lack of public support in the beginning, succumbed to cancer of the lungs in the 84th year of his life which was spent for the good of many future generations of Ohio citizens.

Much of the material for this sketch of Mr. Warner's life was found in an account of his career in "The Land" Vol. II, pp. 263–264, Jan. 1953.

Professor Ralph Wheaton Whipple

Professor of Geology at Marietta College from 1919 to 1954. Fellow of the Geology Section.

Dr. Whipple was born in Philadelphia, Pa. on October 5, 1890 and attended the Dean Academy of Franklin, Mass. for his precollege education. Then he entered Amherst College and received the B.Sc. degree in 1914 and the Master of Arts degree in 1917. He remained at Amherst as assistant in Geology until 1917 when he joined the military forces in World War I. He was the recipient of the Croix de Guerre in 1919. In June of the same year he married Miss Marjorie Davis after having served with distinction in the U. S. Ambulance Corps with the French Army during the entire War, 1917 to 1919.

After the war Mr. Whipple became instructor in Geology at Marietta College in 1919 and in 1920 was promoted to Assistant Professor. In 1925 he was appointed to the Ebenezer Baldwin Andrew Chair of Natural Science at Marietta, and the Curator of the Museum which posi-

tions be held until his death. In 1928 and 1929 Professor Whipple studied at the Sorbonne in Paris.

Two children were born to Professor and Mrs. Whipple, Miss Ann Whipple and James Wheaton Whipple. In addition to the Croix de Guerre he was honored with membership in the Geological Society of America, the AAAS, the Ohio Academy of Science.

On Dec. 4, 1954 Professor Whipple died of cardiac failure in the 64th year of his life survived by his wife and children. After cremation his remains were interred in Columbus, Ohio.

Dr. Frank James Wright

Professor of Geology at Denison University from 1924 to 1949. Member and Fellow of Geology Section.

Frank James Wright was born at Bridgewater, Va. on Nov. 22, 1888 and received the B. A. degree from Bridgewater College in 1908, and the M. A. degree from the University of Virginia in 1911 and his Ph.D. in geology from Columbia University in 1918.

He served as professor of geology and biology at Bridgewater College from 1911 to 1916, then geologist at Bryn Mawr College in 1918, and again at Bridgewater from 1919 to 1924 when he joined the Denison faculty. From 1912 to 1924 he also was employed as the assistant geologist to the Virginia Geological Survey and was for many years the instructor in geology at Columbia University summer sessions. His special field of study was the geology of the Southern Appalachian mountains and the physiography of the James River Basin.

Among the honors Dr. Wright received were the Walker Prize of the Boston Society of Natural History and the Cressy Morrison Prize of the New York Academy of Science in 1931. He was a member of the A.A.A.S.; Fellow of the Geological Society; The Geography Association and Fellow and Vice-President (1931) of the Ohio Acad. Science. He was also a member of the A.A.U.P., Phi Gamma Delta, Phi Beta Kappa, Sigma Xi and Omicron Delta Kappa.

In 1914 Dr. Wright married Anna Catherine Zigler and to them was born two sons—Robert James Wright and Harold Douglas Wright. On September 5, 195- Dr. Wright died of a cerebral hemorrhage and later was buried at Bridgewater, Va.

Respectfully submitted,
H. H. M. Bowman, *Chairman*
J. H. Melvin
Paul Rothemund

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